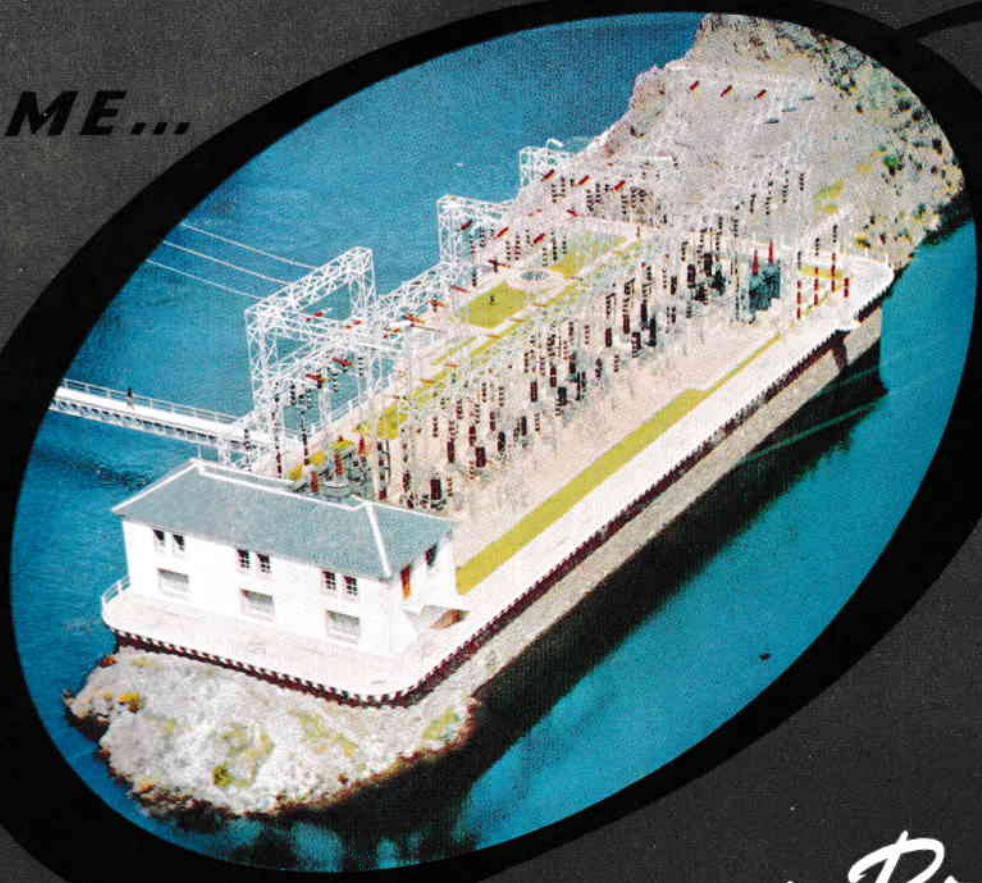
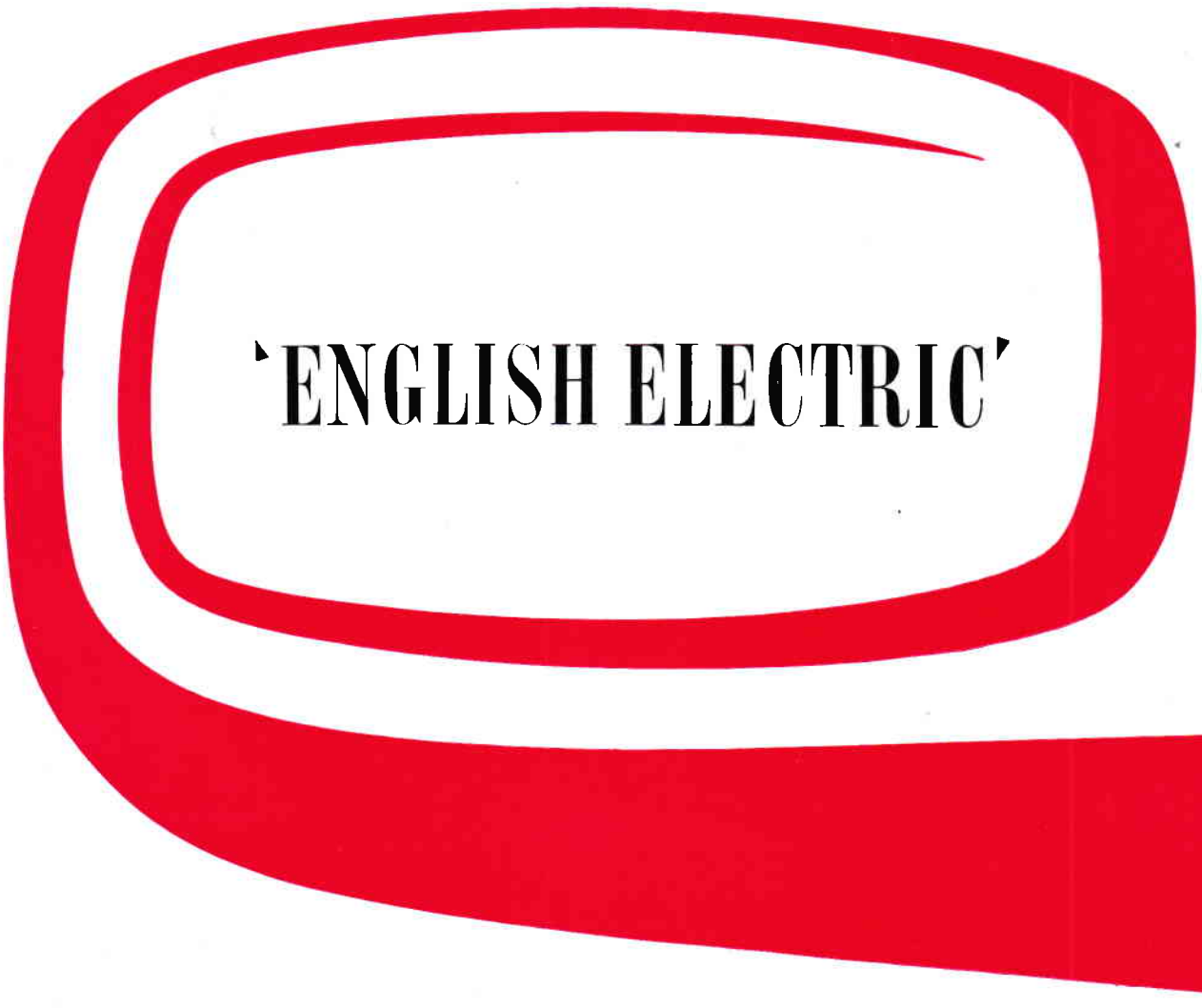
FRAME...



Air-Blast Circuit-Breakers

'ENGLISH ELECTRIC'

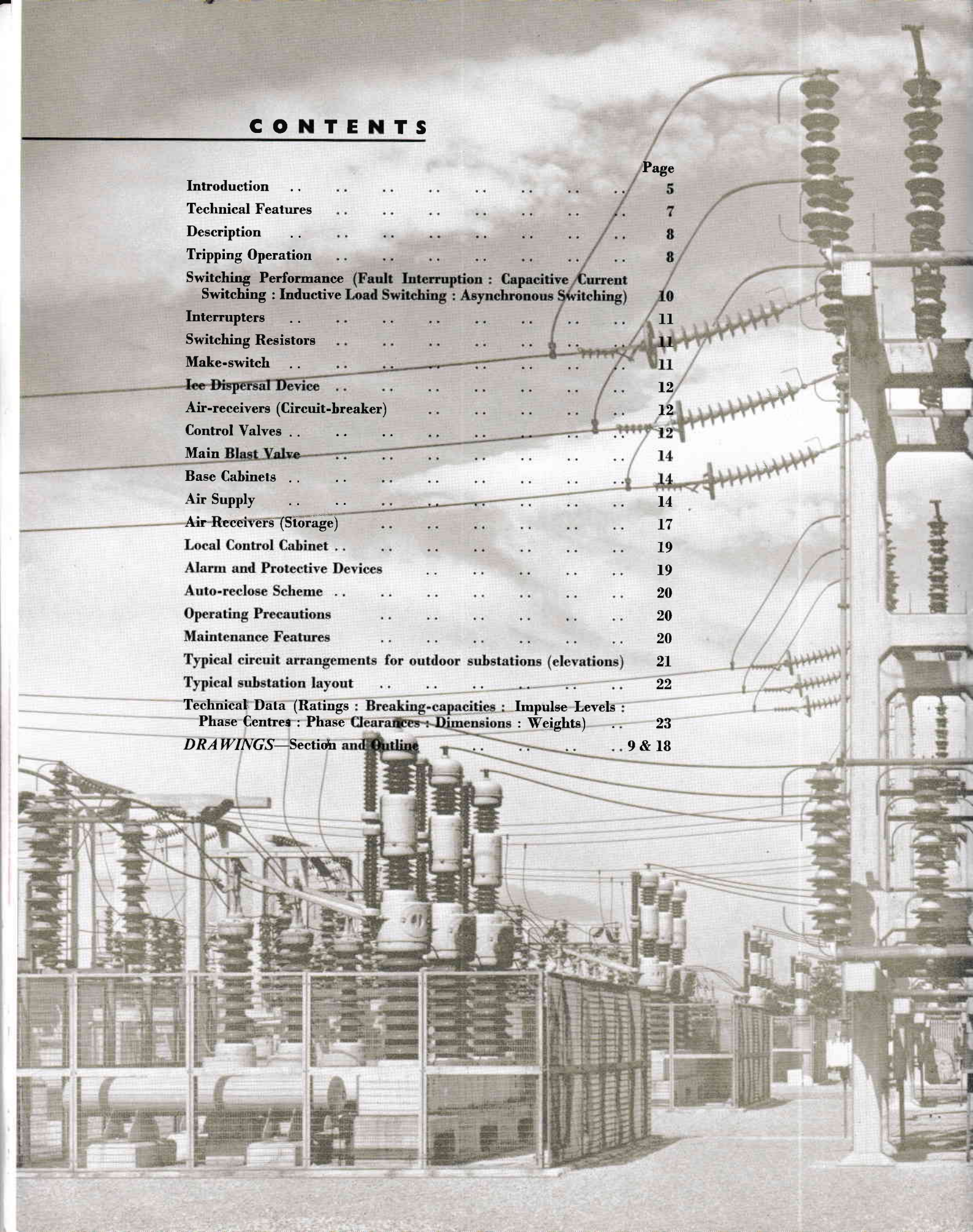

'ENGLISH ELECTRIC'

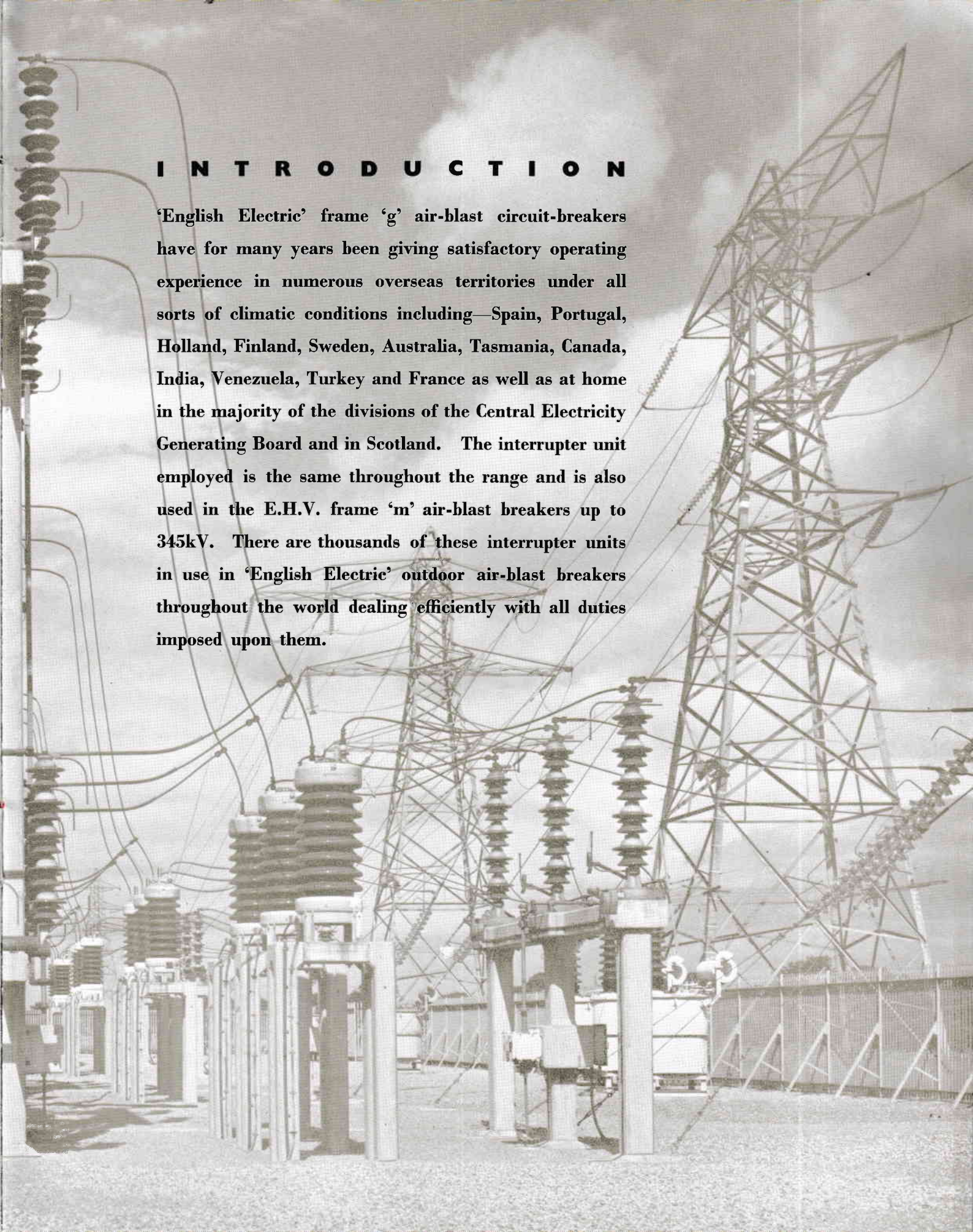
AIR-BLAST CIRCUIT-BREAKERS

FRAME 'g' 110-165kV

The illustration shown on the front cover is of the switching station for the Ponte Novo H.E. Power Station of Saltos del Sil S.A. in Spain containing 165kV 3500MVA air-blast circuit-breakers. A closer view of the breakers is shown on the inside back cover.

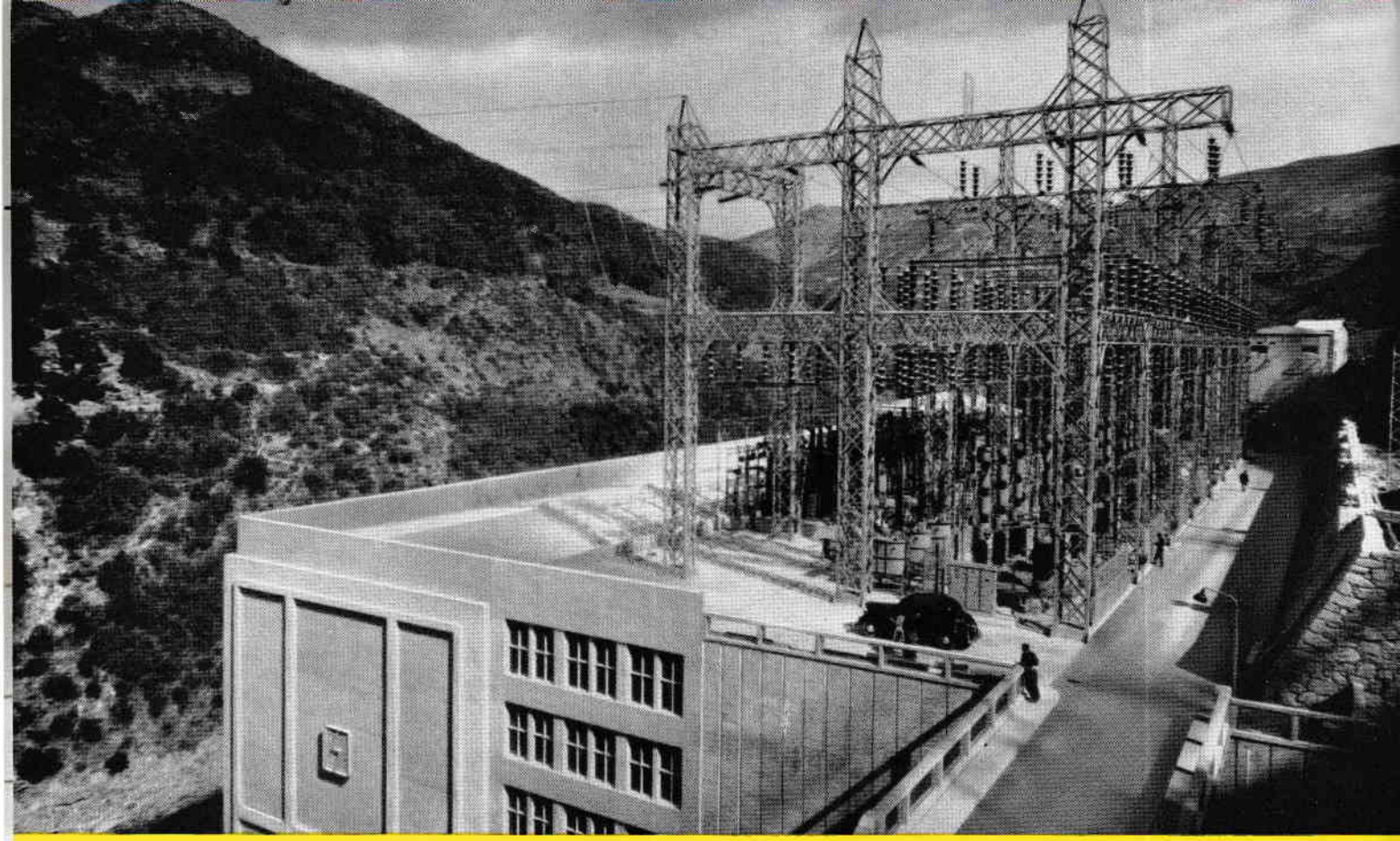
CONTENTS





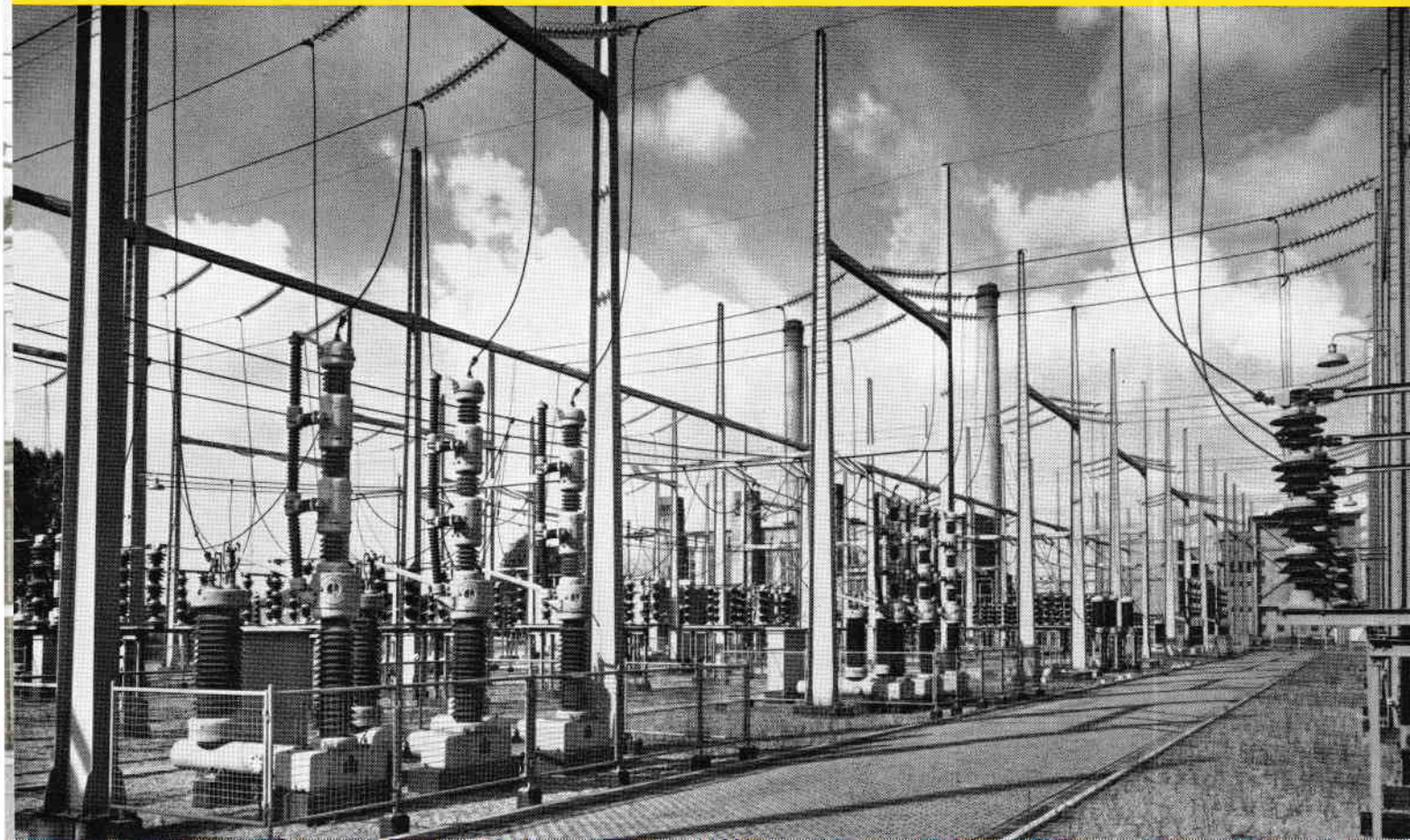
INTRODUCTION

'English Electric' frame 'g' air-blast circuit-breakers have for many years been giving satisfactory operating experience in numerous overseas territories under all sorts of climatic conditions including—Spain, Portugal, Holland, Finland, Sweden, Australia, Tasmania, Canada, India, Venezuela, Turkey and France as well as at home in the majority of the divisions of the Central Electricity Generating Board and in Scotland. The interrupter unit employed is the same throughout the range and is also used in the E.H.V. frame 'm' air-blast breakers up to 345kV. There are thousands of these interrupter units in use in 'English Electric' outdoor air-blast breakers throughout the world dealing efficiently with all duties imposed upon them.



Portugal
Outdoor sub-station equipped with 165kV 3500MVA air-blast circuit-breakers, frame 'g' and erected on the roof of the Vila Nova Hydro-electric Power Station.

Holland
150kV 3500MVA air-blast circuit-breakers installed at Nijmegen sub-station for the P.G.E.M.



TECHNICAL FEATURES

The air-blast circuit-breaker provides the best overall solution to the various types of switching duty to which circuit-breakers are subjected.

Mechanical reliability. Ensured by simplicity of moving parts and facility of control by compressed air.

Electrical reliability. Arc interruption performance consistent over entire operating range, from magnetising currents to full short-circuit currents.

Dielectric supply renewed in the form of high-pressure air at each operation.

Designed and tested for use at temperatures down to −40°C. and under ice conditions.

Built on the unit interrupter principle. Enables the breaker to be 100% tested for short-circuit rating by applying maximum test plant output to individual interrupters.

Ease of maintenance. One of the main advantages of the air-blast over the oil circuit-breaker. All parts readily accessible for inspection and easily removable if required. Interrupter units can be withdrawn from their housings through doors provided, without disturbance of other parts.

Complete elimination of explosion and oil fire risks.

Description

THE circuit-breaker consists of three single-phase units which are coupled together pneumatically and electrically, thus giving simultaneous operation of all three phases.

Each phase consists of a horizontally-mounted air receiver, a main interrupter column, a make-switch blade and either a post insulator or a large diameter insulator inside which is housed a current-transformer. Both forms carry the make-switch fixed contacts assembly and incoming line terminal. Beneath each main column is a base cabinet having three compartments, each fitted with a removable weatherproof cover.

Each main interrupter column consists of a large hollow porcelain insulator on which is mounted the make-switch operating mechanism, the interrupters with their respective support insulators, coolers and exhausts and also the switching resistors (when required). Inside the large hollow porcelain insulator are air tubes up which the air blast travels to the interrupters and make-switch opening and closing cylinders.

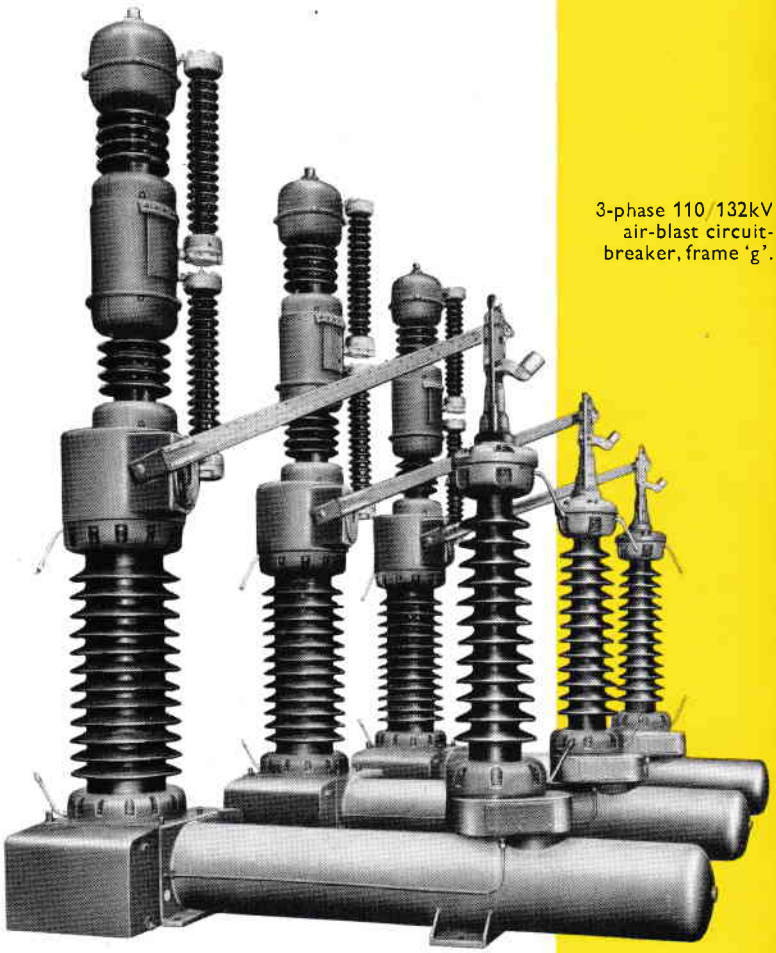
Tripping Operation

The circuit-breaker may be 'tripped' by local or remote manual operation of a Close/Trip control switch or through the occurrence of a fault.

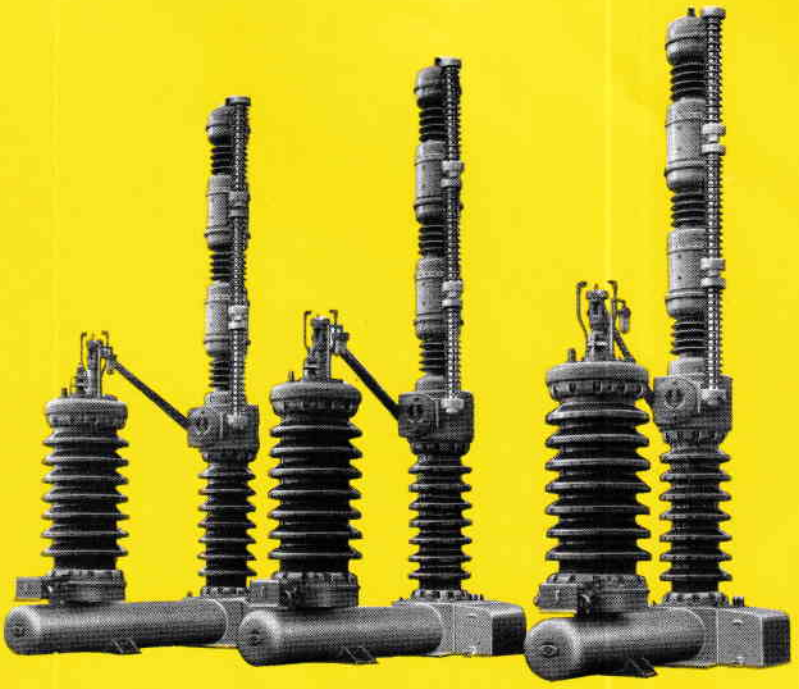
As a result, the electro-pneumatic control valve operates and air is admitted to the main blast valve, causing it to open and allowing the air stored in the breaker receiver to travel at speed up the vertical columns to the interrupters and the opening cylinders of the make-switches.

Immediately the air reaches the interrupters, it forces the spring-loaded moving contacts downwards and away from their respective fixed contacts. The arc resulting from this separation of the contacts, is swept away at an early current zero by the scavenging effect of the air-blast, which carries the arc products with it into the cooler chamber, where they are expanded and cooled before passing out to atmosphere through the exhaust vents. Special arcing probes are provided to carry the arc during the short period of its existence and thereby protect the normal current-carrying surfaces.

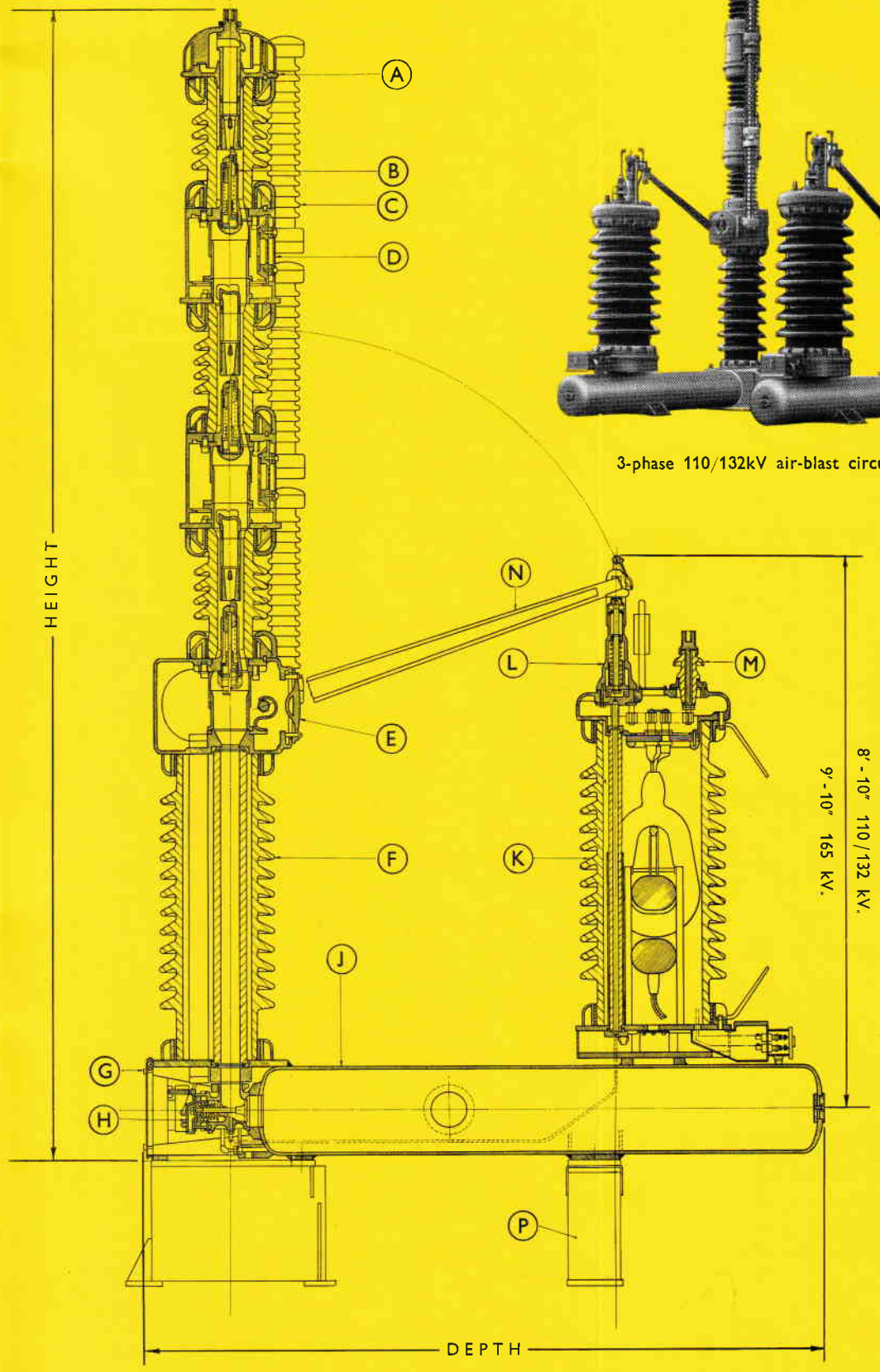
The interrupter unit may be easily withdrawn through the door provided, without disturbing any other part of the breaker. This renders inspection extremely simple.



3-phase 110/132kV air-blast circuit-breaker, frame 'g'.



3-phase 110/132kV air-blast circuit-breaker, frame 'g', with C/T.



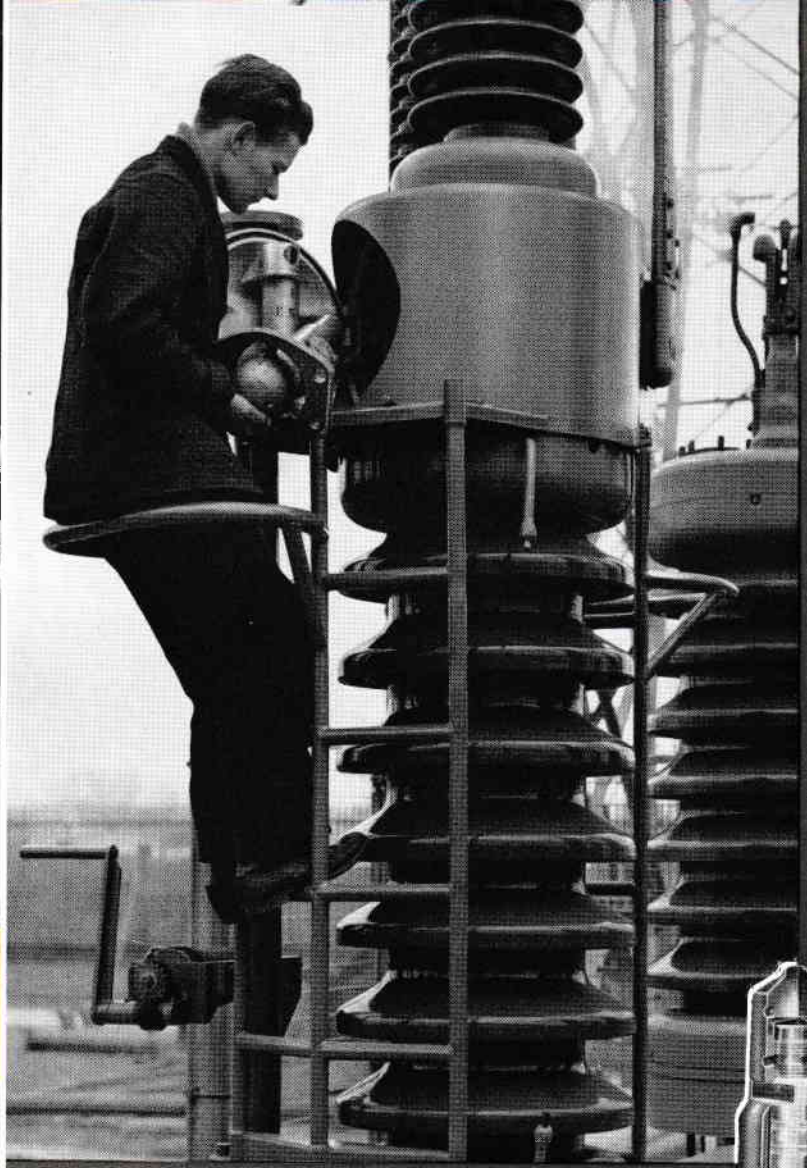
Sectional elevation of 3-phase 132kV 3500MVA air-blast circuit-breaker, frame 'g', with current-transformer.

For dimensions see page 23

DESCRIPTION

Ref.

- **A** *Top Cooler*
- **B** *Interrupter Unit*
- **C** *Switching Resistor*
- **D** *Intermediate Cooler*
- **E** *Mechanism Housing*
- **F** *Main Support Insulator*
- **G** *Control Cabinet*
- **H** *Main Blast Valve*
- **J** *Air Receiver*
- **K** *Current-trans. Insulator*
- **L** *Make-switch Contact and De-icer*
- **M** *Line Terminal*
- **N** *Make-switch Blade*
- **P** *Support Stools*



Removing Interrupter Unit from mechanism housing.

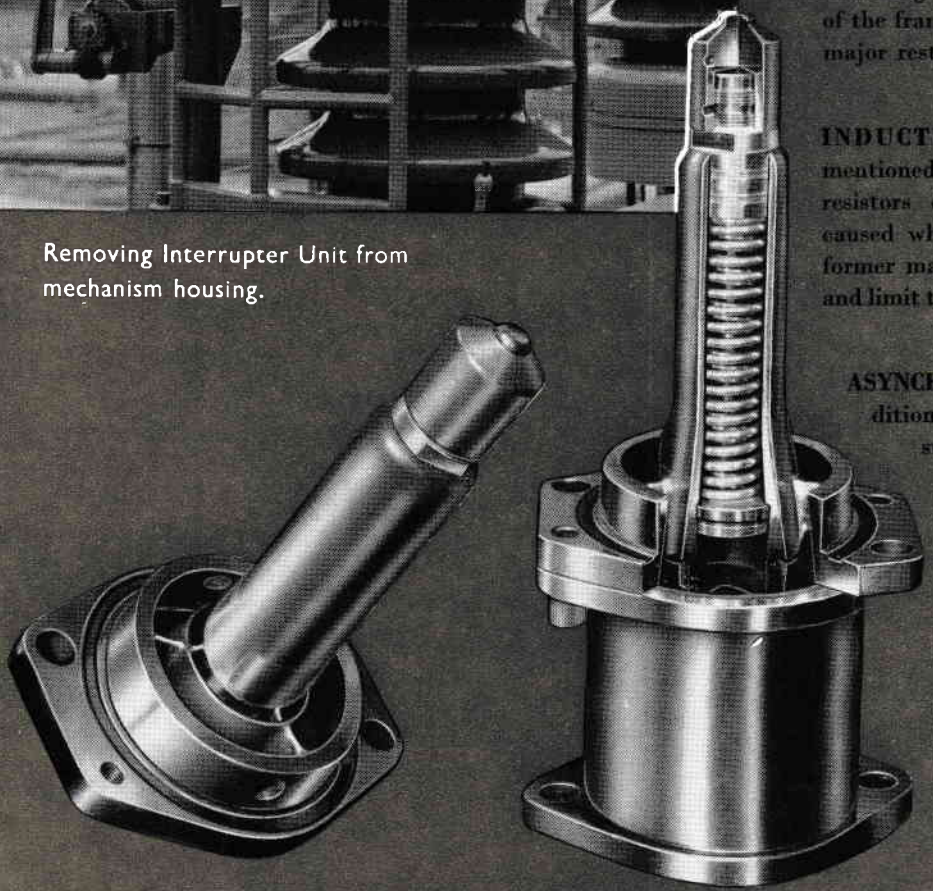
Switching Performance

FAULT INTERRUPTION. Having a fresh supply of dielectric at each operation, air-blast breakers are particularly suitable for fault duty. Contact burning and maintenance is considerably less than in other types.
As they consist of a number of unit interrupters the air-blast breakers can be fully proved for the highest breaking-capacity ratings by means of unit testing.

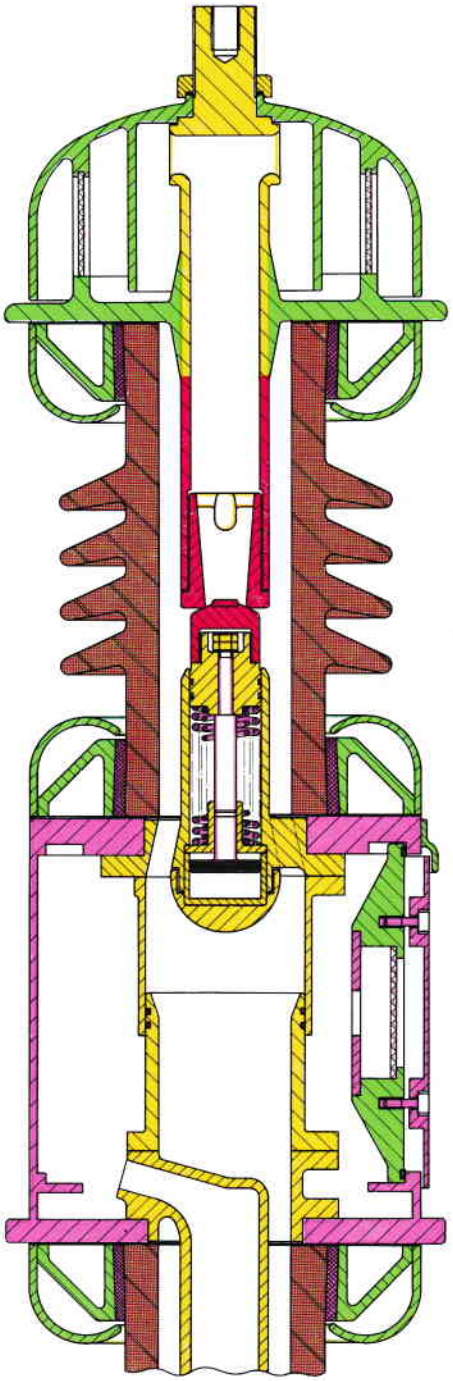
CAPACITIVE CURRENT SWITCHING. The problem when switching capacitive currents, e.g., line charging currents, is to build up quickly sufficient dielectric strength between the contacts to withstand twice normal voltage one-half cycle after interruption. Air-blast breakers do this by forcing high pressure fresh dielectric through the interrupter, and thus are ideally suited for the duty. Full scale line switching tests have proved the effectiveness of the frame 'g' breakers in this regard and no major restrikes occur.

INDUCTIVE LOAD SWITCHING. As mentioned under "Switching Resistors" the resistors damp out transient over-voltages caused when the breaker is switching transformer magnetising or shunt reactor currents, and limit the over-voltages to a harmless value.

ASYNCHRONOUS SWITCHING. This condition can be covered by incorporating sufficient interrupters in the circuit-breaker to meet any normal asynchronous switching condition.



The Mk. II interrupter used in all 'English Electric' outdoor air-blast breakers from 110 kV. to 345 kV.



Interrupters

The interrupter, shown in section above, is a standard unit assembly comprising a manganese bronze body casting enclosing a spring-loaded moving copper contact. The latter, when thrust upwards by the force of the spring, makes contact with the copper fixed contact immediately above it; a steel piston operates behind the sliding portion and acts in a buffering capacity for both the opening and closing movements. Each interrupter has its own cooler of such volume as to permit unrestricted air flow during the time required for arc extinction.

Switching Resistors

Where required, linear resistances of the carbon ceramic type are connected electrically in parallel with each interrupter. They are fitted with current quenching gaps which break down early in the interruption stage inserting the resistance in parallel with the interrupters. These resistors serve a dual purpose by (1) equalising the voltage across the interrupter and so enabling the highest rating to be obtained and (2) damping out high re-striking voltage transients caused by chopping action when the breaker is interrupting at low values of reactive current. Hence the breaker is suitable for operation on any type of circuit, including shunt connected reactors.

Make-Switch

The make-switch comprises a cadmium copper blade operated pneumatically from the main interrupter column and 'making' with a set of fixed contacts which are situated on the top of either the post insulator or C.T. column, whichever is fitted. The make-switch serves a dual purpose. It provides stand-by air clearance when the breaker is open and also 'makes' the circuit when the breaker closes, the interrupter moving contacts having previously closed under the pressure of their own springs after the breaker has fully opened.

The make-switch blade is operated pneumatically by air engines installed in the mechanism housing. Air to these engines is automatically fed from the air receiver via the

main blast valve up the two air feed tubes, which stand inside the large hollow main support insulator. The relative diameter of the feed tubes compared to the diameter of the main blast tube is such as to ensure that the make-switch arms cannot move until the arc is extinguished. Separate air engines are provided for the 'opening' and 'closing' operations, as this permits fine adjustment for ideal buffering by pneumatic damping on the two duties thereby reducing stresses to the absolute minimum. Air is also fed to the make-switch fixed contact assembly to operate the ice dispersal device (See 'Ice Dispersal Device'). The opening movement of the make-switch blade imparts a rotary movement to one of the air feed tubes which operates an auxiliary switch in the base cabinet ; this, in addition to **cutting off the supply to the control valve, thereby shutting-off the air supply, also operates breaker 'open' and 'closed' indicators in the control cabinet.**

Ice Dispersal Device

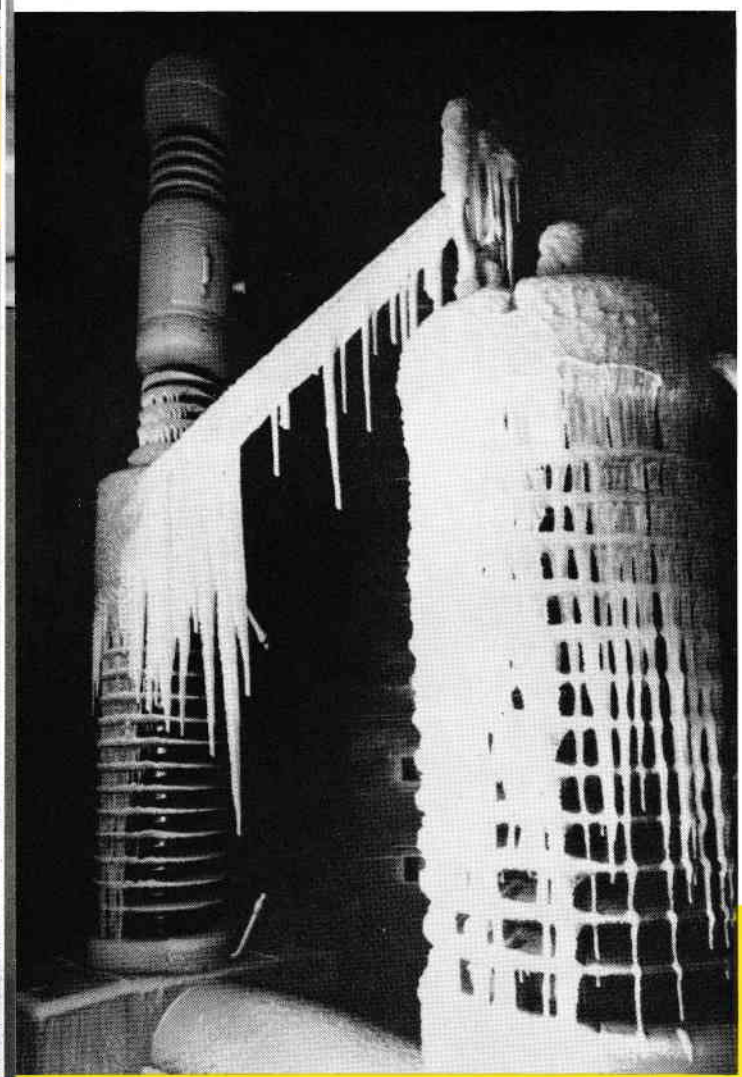
Incorporated in the make-switch fixed contact assembly is a pneumatically-operated piston which imparts to the make-switch blade a sharp blow to (*a*) disperse any ice that may have formed on it and (*b*) free the blade from the fixed contacts where it may have become tight due to the breaker remaining in the closed position for a long period. This device may also be operated to ensure satisfactory closure by removing any ice that may have formed on the fixed contacts during the time the make-switch blade had remained open.

Air Receivers (BREAKER)

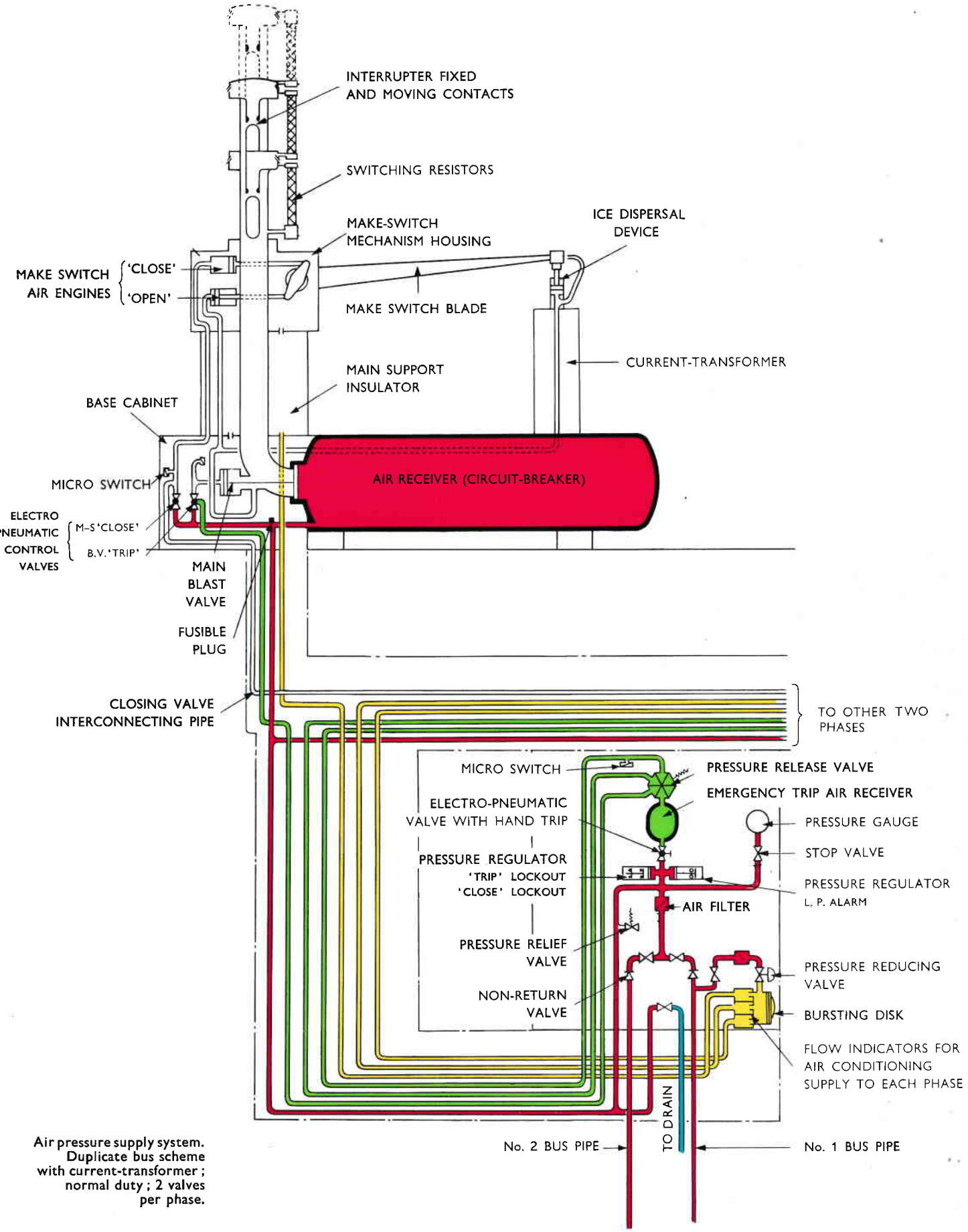
The breaker receivers are of solid-drawn construction and have an inspection hole at each end fitted with a removable cover. The inside surface is treated with a light-coloured anti-corrosion paint. All receivers are officially tested hydraulically at the works and are fully approved by the leading insurance companies who do not require periodic hydraulic tests at site.

Control Valves

The control valves, which are of the high-speed type and are electro-pneumatically operated, control the high pressure air from the breaker receiver for 'closing' or 'tripping' the breaker. A feature of these valves is the retaining contacts which ensure a full and positive operation once initiated.



Frame 'g' air-blast circuit-breaker undergoing low temperature and icing tests.



Air pressure supply system. Duplicate bus scheme with current-transformer; normal duty; 2 valves per phase.

Main Blast Valve

The main blast valve, of which there are three per breaker (one per phase) is located in the cabinet at the base of each main interrupter column and, if required, may be removed with minimum disturbance of other parts of the breaker.

Metal valves and seats are used in the blast valves and the control valves to ensure consistent long life under all climatic conditions.

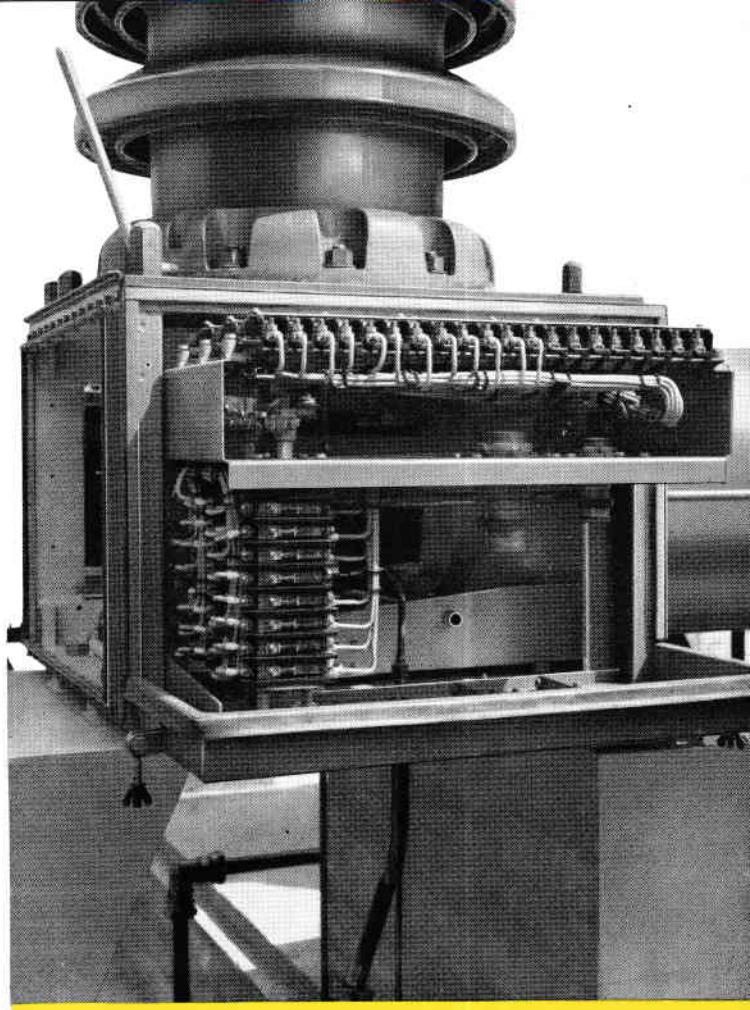
Base Cabinet

Each phase of the circuit-breaker includes base cabinets weatherproofed and provided with watertight removable covers. Housed in the cabinets are the control valves, main blast valve, auxiliary switches, low-voltage wiring, terminal boards, multi-core cable glands, resistors and heaters.

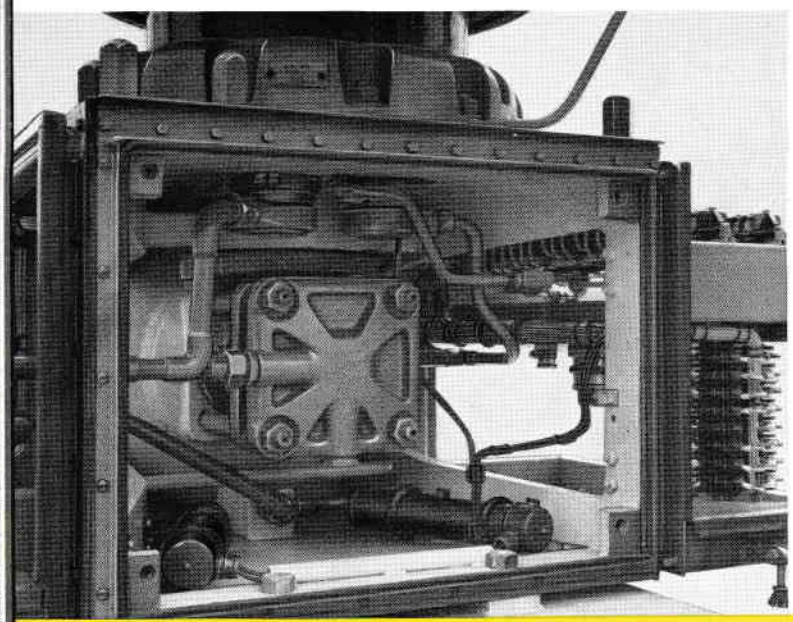
Air Supply

(See publication—Compressor Equipments Type AC)

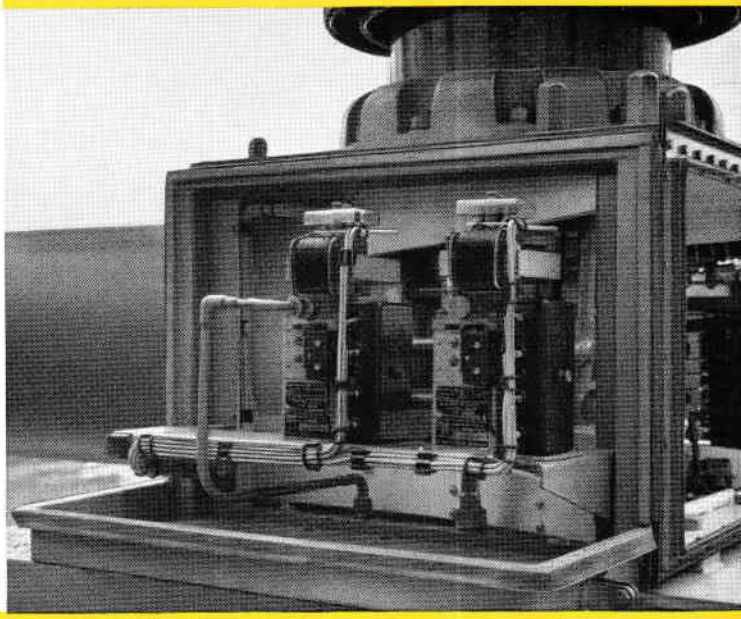
Compressed air for one make and break opera-



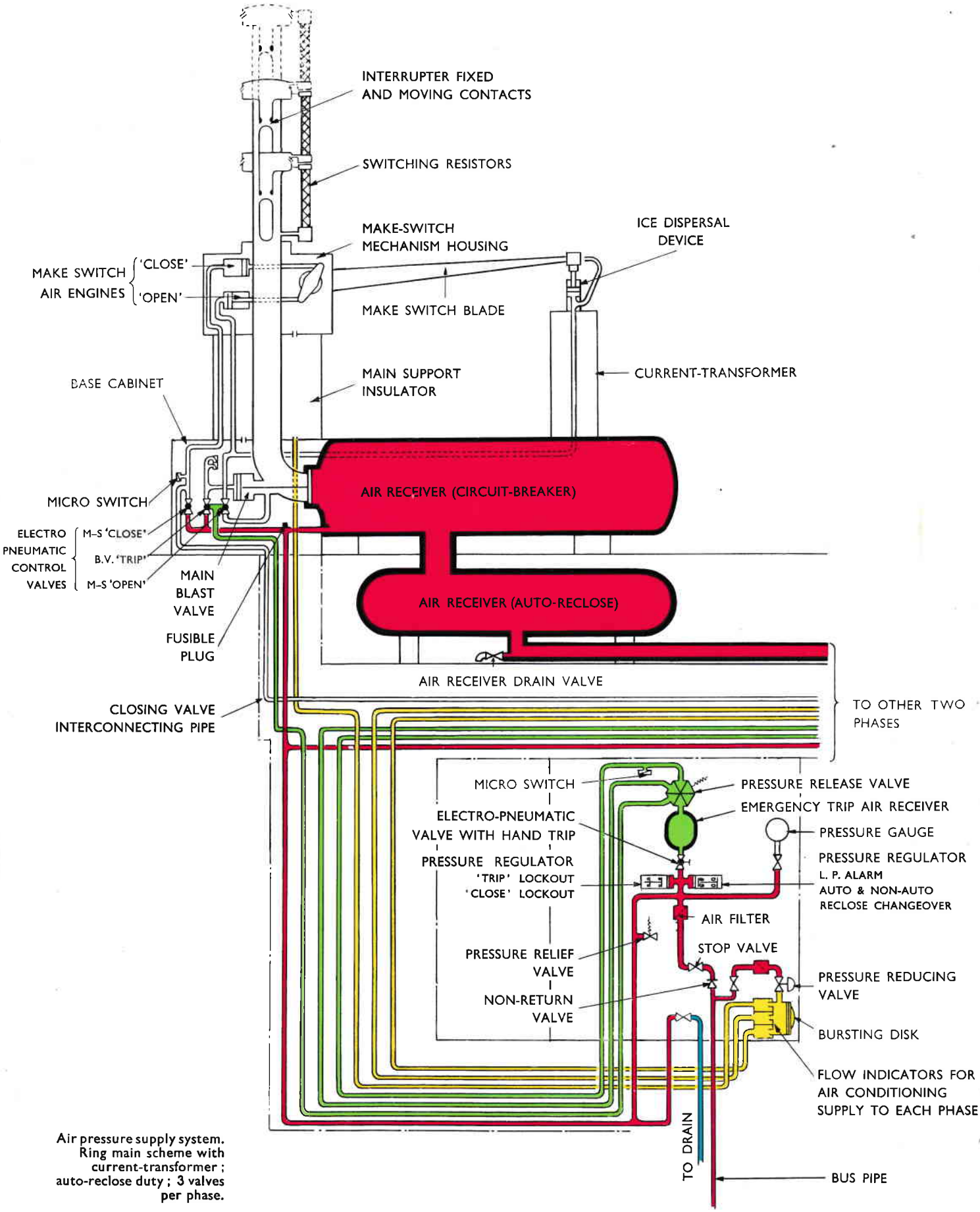
Base cabinet. Side compartment housing terminal boards and auxiliary switches.



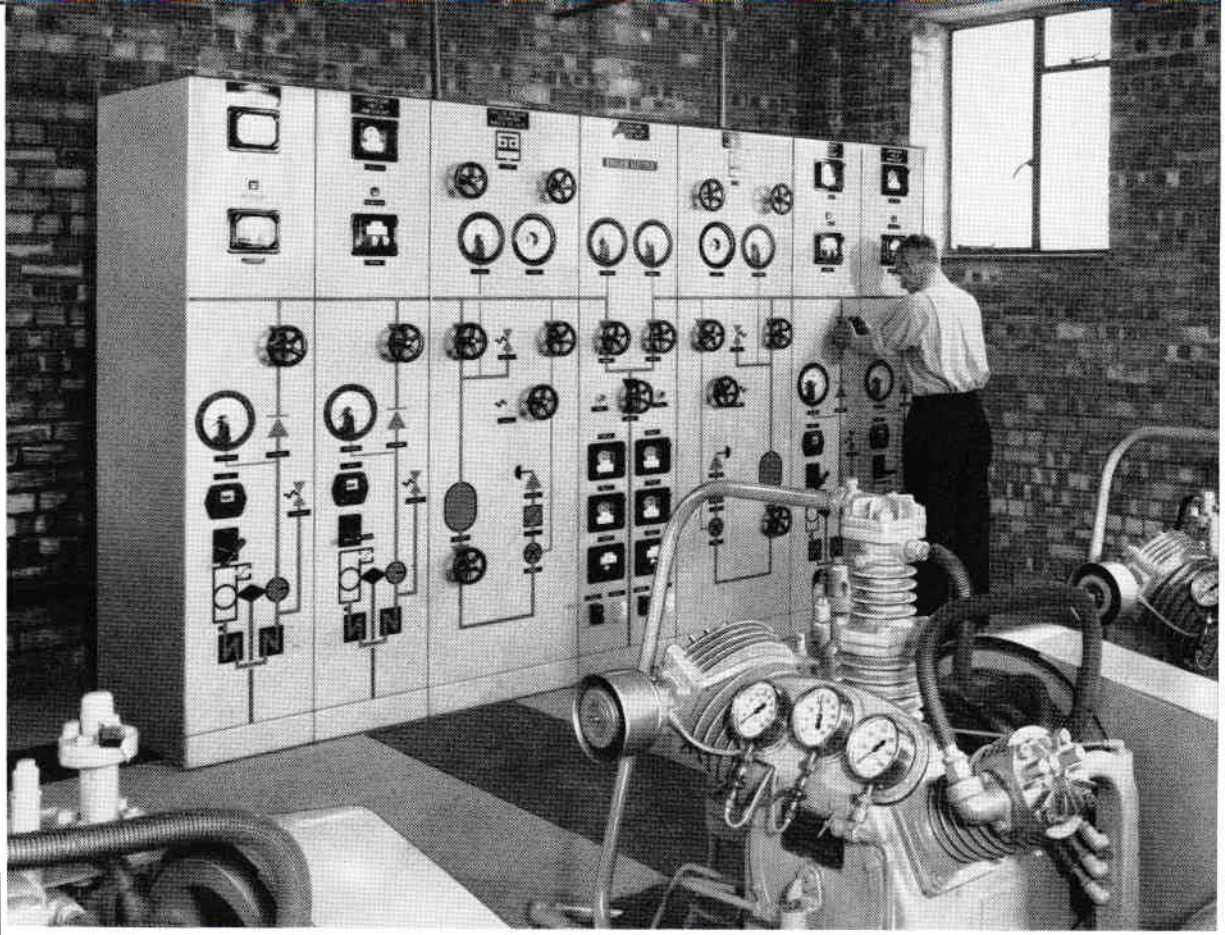
Base cabinet. Centre compartment housing main blast valve.



Base cabinet. Side compartment housing high-speed electro-pneumatic control valves.



Air pressure supply system. Ring main scheme with current-transformer ; auto-reclose duty ; 3 valves per phase.



Compressed air, supply distribution board.

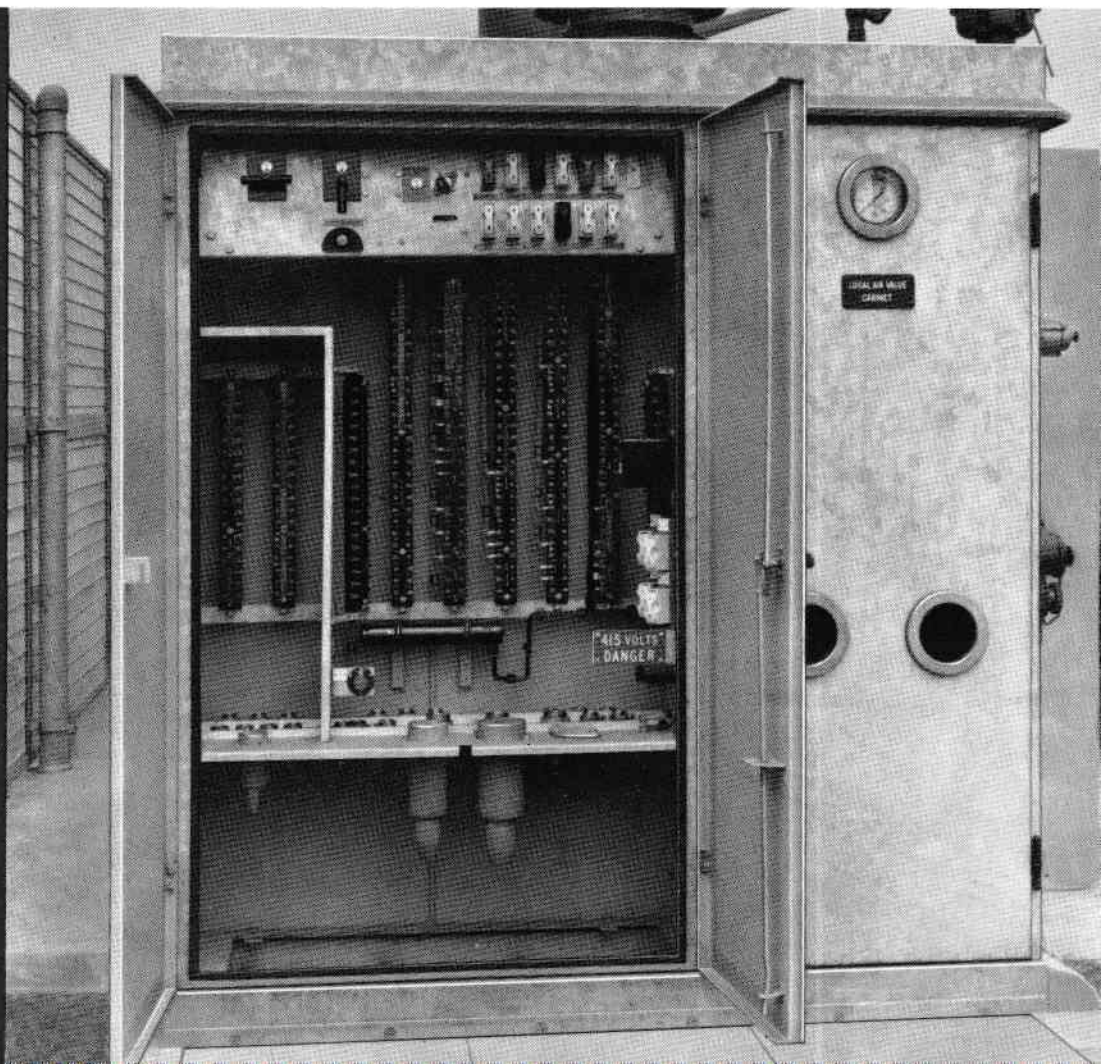
High pressure air storage receivers mounted outside a compressor house

tion is normally stored in the breaker receivers, which are fitted with a non-return valve to prevent loss of air from one pressure system to the other when the compressors are shut-off. Extra air storage capacity is provided when required for high-speed reclosing or two make/break operations.

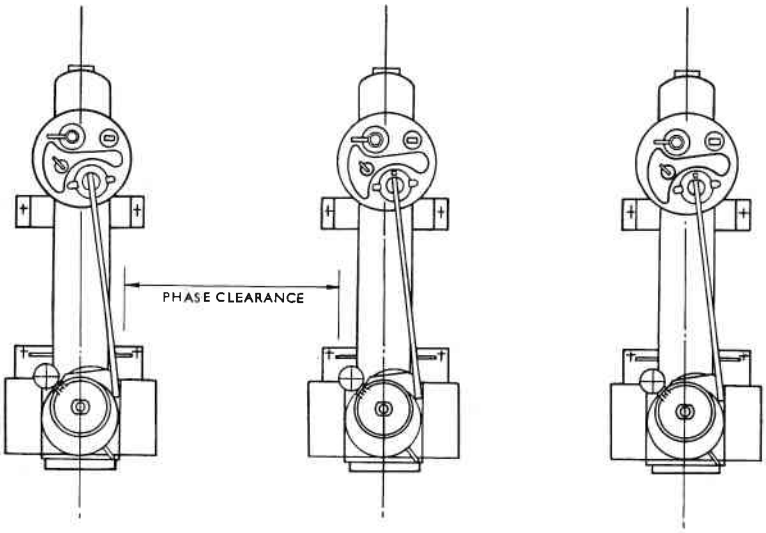
The whole process of storage and supply of compressed air is automatic and the pressure cycle through which the air is taken causes separation of the water to occur in the main receiver, from which it can be periodically drained. The subsequent reduction to half the pressure halves the humidity and ensures that no water is deposited in the breaker receivers. Control is automatic, the compressor being started up and shut down by fall and rise in pressure respectively and a low-pressure alarm is given at the compressors. Sequential starting is employed to avoid excessive drop and disturbance in the power mains.

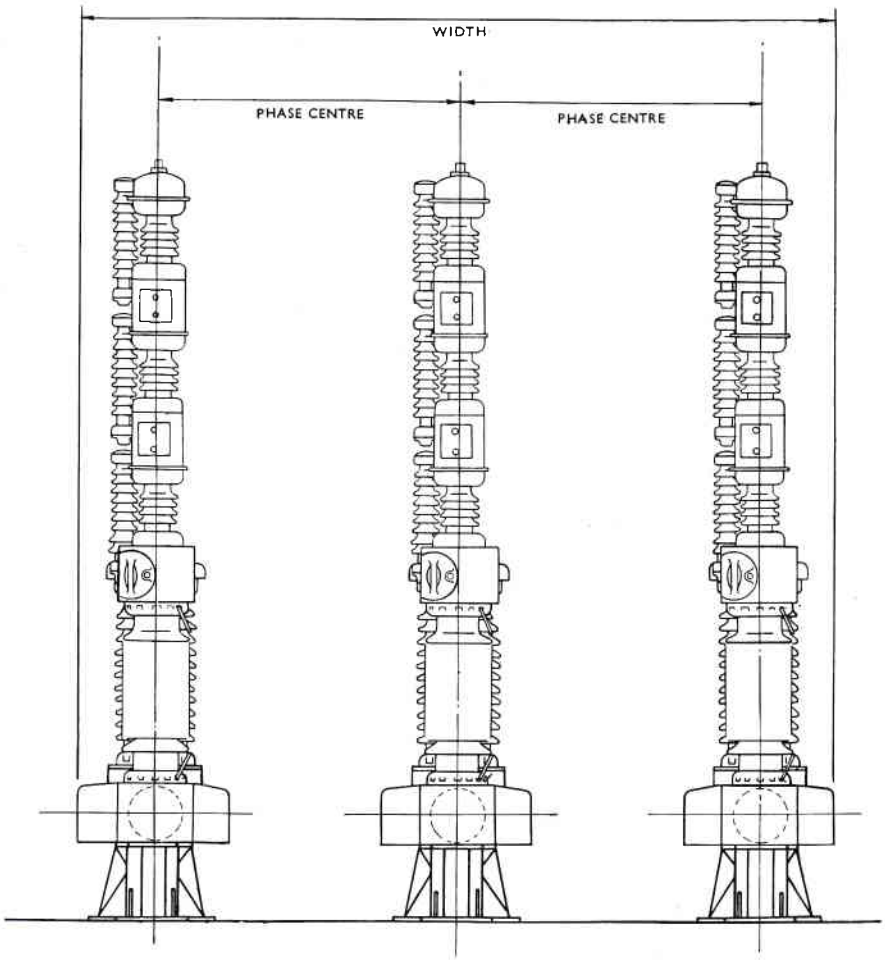
Air Receivers (STORAGE)

The high-pressure air storage receivers are mounted out of doors, to ensure that the air stored in them is at the same temperature as the breaker receiver. They are of fusion welded construction and have manholes and inspection holes in compliance with British Standards. The inside surface is treated with a light-coloured anti-corrosion paint. These receivers are fully approved by the leading insurance companies and it is recognised that after the official hydraulic test at the Works, regular periodic hydraulic testing on site will not be required.



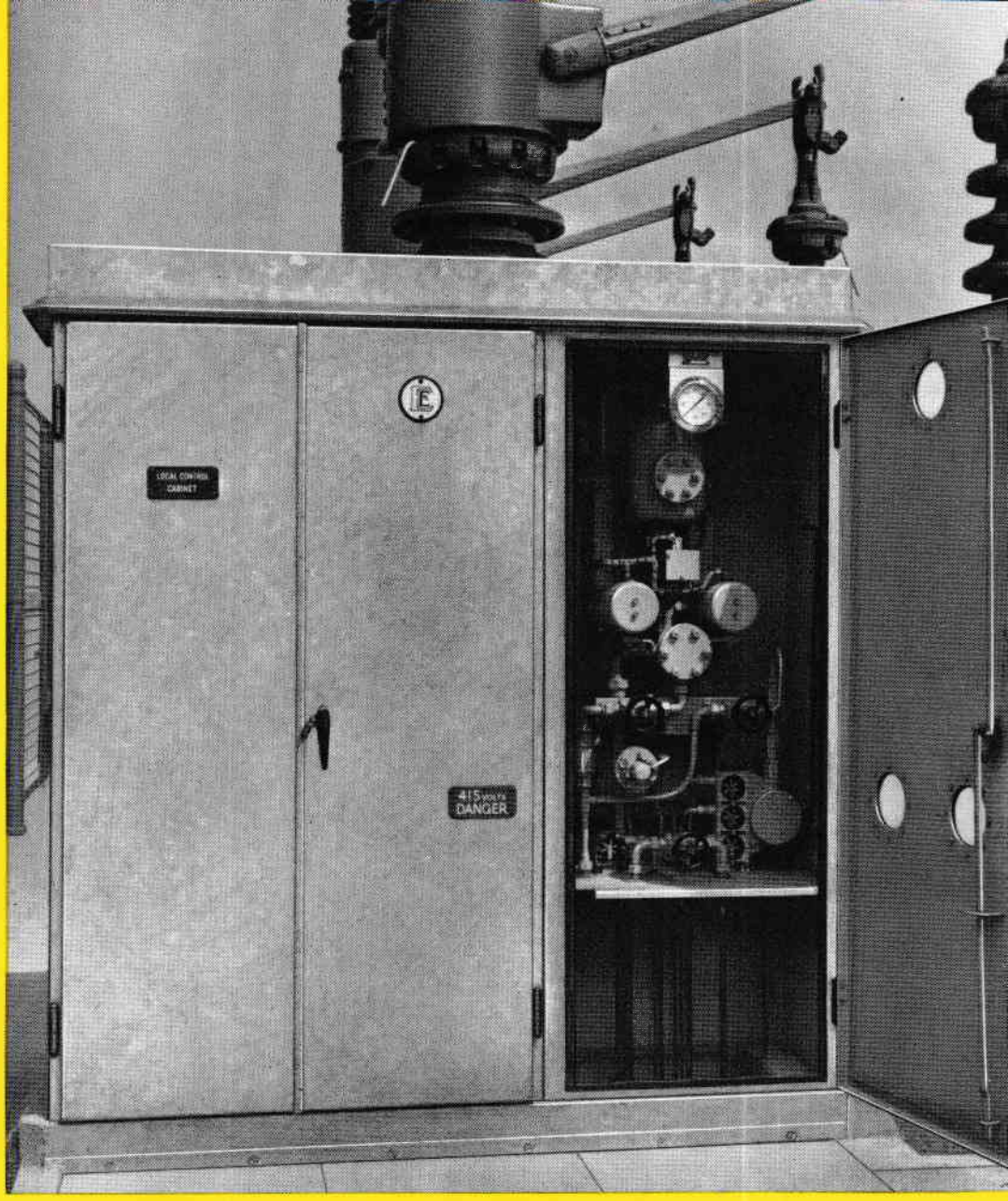
Local air valve and control cabinet with door to control cabinet open





Outline of 3 phase 132 kV 3500 MVA A blast Circuit-Breaker with current-transformer. Frame ' g '.

For dimensions see page 23



Local air valve and control cabinet with door to air valve cabinet open.

Local Control Cabinet

Each circuit-breaker is supplied with a weatherproofed combined local air valve and control cabinet, into which are taken the main bus air supply pipes and the multi-core cabling for the breaker. The cabinet also contains the air control panel, emergency trip receiver, hand-operated emergency trip device, back-up electro-pneumatic control valve, relief and drain valves, low pressure interlock and alarm, air filter, flow indicators for air conditioning supply to each phase, local control switch, local remote selector switch, indication lamps, fuses, terminal boards, cable glands and heaters.

Alarm and Protective Devices

(a) *Low Air Pressure Alarm for Breaker Receivers*

This alarm gives warning when the air pressure falls below the minimum working pressure. A

delay feature is included to prevent alarm being given during the momentary drop in air pressure which occurs when the breaker operates.

(b) *Low Air Pressure Lock-out*

This device prevents a tripping or closing operation being initiated when the air pressure is below that required for service.

(c) *Emergency Trip*

A hand-operated pneumatic emergency device, operated from the local cabinet, enables the circuit-breaker to be tripped independently of the electrical control circuit. If the low air pressure lock-out is functioning, the emergency trip is inoperative.

(d) *Anti-hunting Relay*

This device prevents the breaker "hunting", i.e., rapidly opening and closing, in the event of the circuit-breaker being closed on to a fault.

Auto-Reclose Scheme

This is accomplished on the interrupter contacts which are held open by the compressed air supply during the 'dead time' and then allowed to reclose so as to remake the circuit. Additional control valves block the air supply to the make switch which remains closed during this period. If the fault persists after the circuit is remade, the circuit-breaker trips again, but this time it opens normally and locks out.

The scheme provided includes the necessary control relays and any additional air storage which may be required.

As the air-blast breaker consists of three independent phases it can easily be adapted for either three-phase or single-phase reclosing. Alternatively, both can be provided, with a hand-operated selector switch.

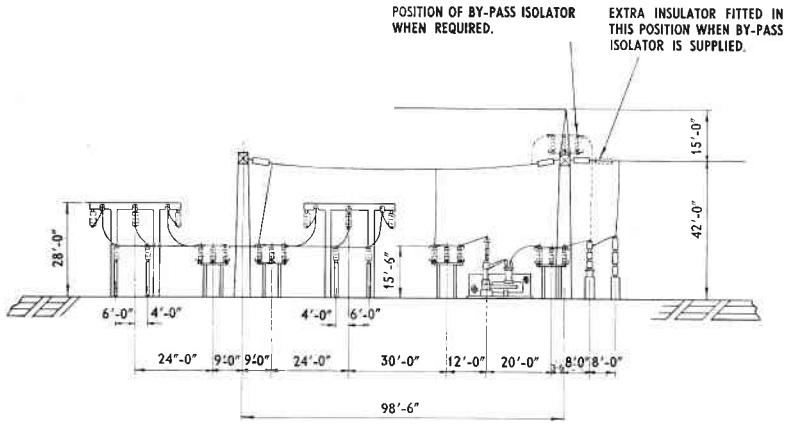
Operating Precautions

To guard against any possible incorrect functioning of the pneumatic control valves, precautions have been taken in developing the electrical and pneumatic control schemes of the circuit-breaker by ensuring alternative operation should the normal method fail. This has been carefully devised with an appreciation of the possible consequences of a failure, however remote this may be.

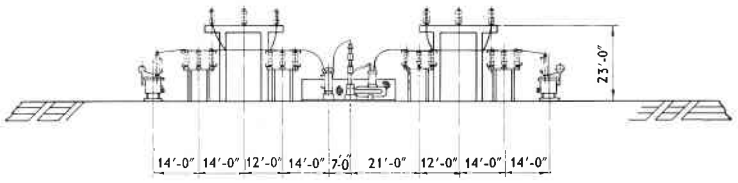
Maintenance Features

Each substation is provided with a set of portable steel ladders and davit. The ladders are in sections and can be attached to the sides of any of the main interrupter columns enabling general inspection work to be carried out and any of the interrupter units to be removed for routine examination as desired. The davit has a maximum working load of 6 cwt. It is in sections and is perfectly secure when attached to the main column. The top of the davit consists of a swinging jib so that sections of the interrupter column and the switching resistors can be raised or lowered during erection or for maintenance purposes. Publication SG/236 fully illustrates these features.

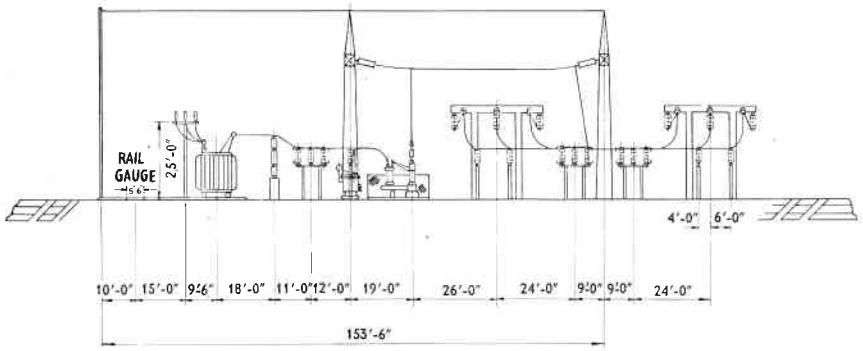
NOTE :— Due to the introduction of improvements from time to time the right is reserved to supply products which may differ slightly from those illustrated and described in this publication.



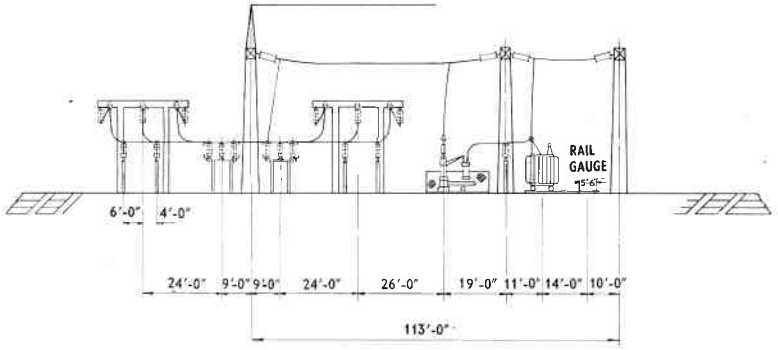
SECTION OF FEEDER BAY



SECTION OF BUS COUPLER BAY WITH BUS BAR V.Ts.



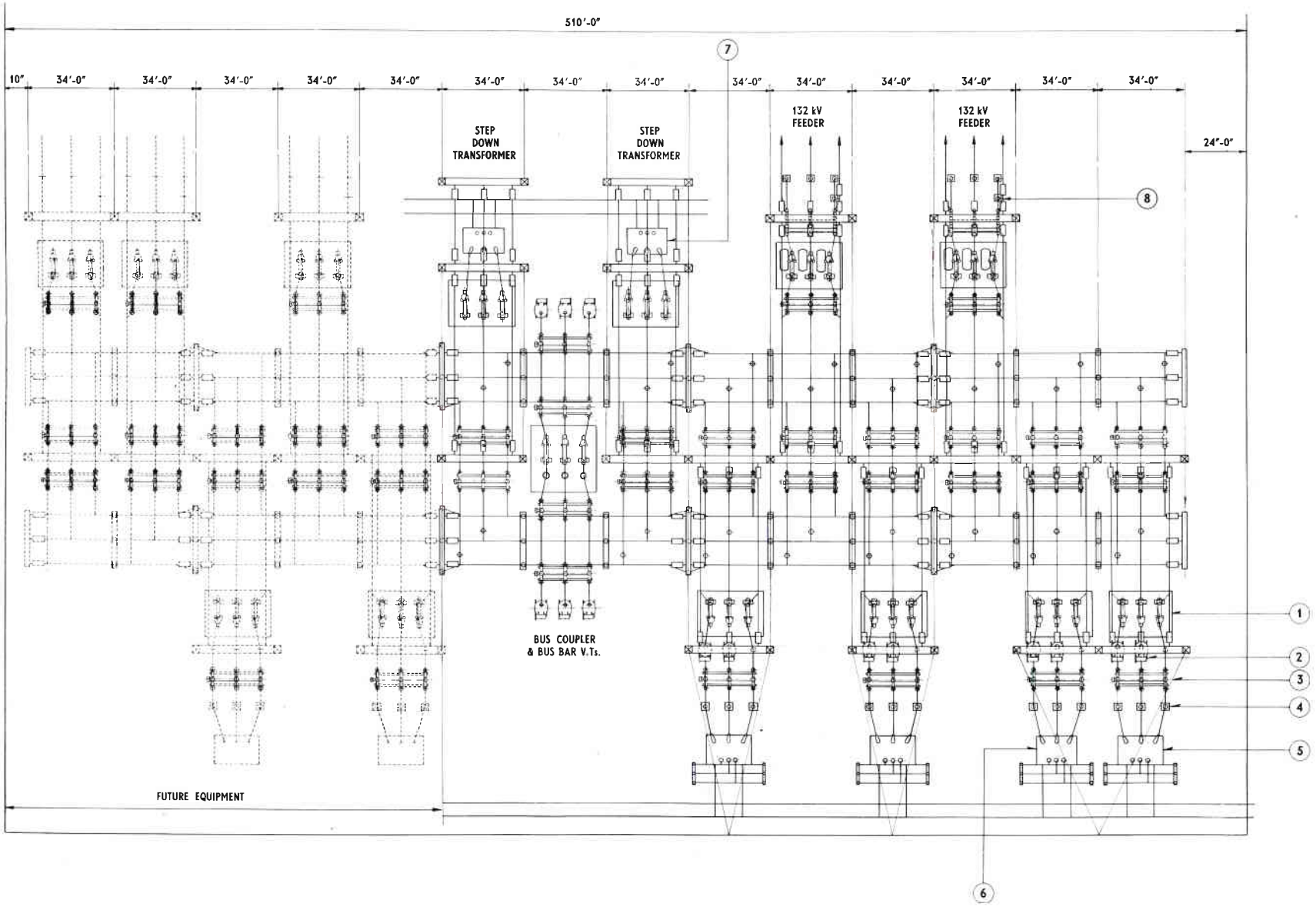
SECTION OF TRANSFORMER BAY WITH VOLTAGE-TRANSFORMER AND TRANSFORMER ISOLATOR



SECTION OF AUXILIARY TRANSFORMER BAY

Typical circuit arrangements for outdoor substations (elevations).

Typical layout of a 132kV outdoor sub-station with 132kV 3500MVA air-blast circuit-breakers; frame 'g'.



1. Air-blast breaker with C/T's.
2. 132kV Voltage transformer.
3. 132kV R.C.P. Isolator.
4. 132kV Lightning Arrester.
5. 11/132kV 35MVA Step-up transformer.
6. 132/3·3kV Station transformer.
7. 132/3·3kV 20MVA Transformer.
8. Line Trap.

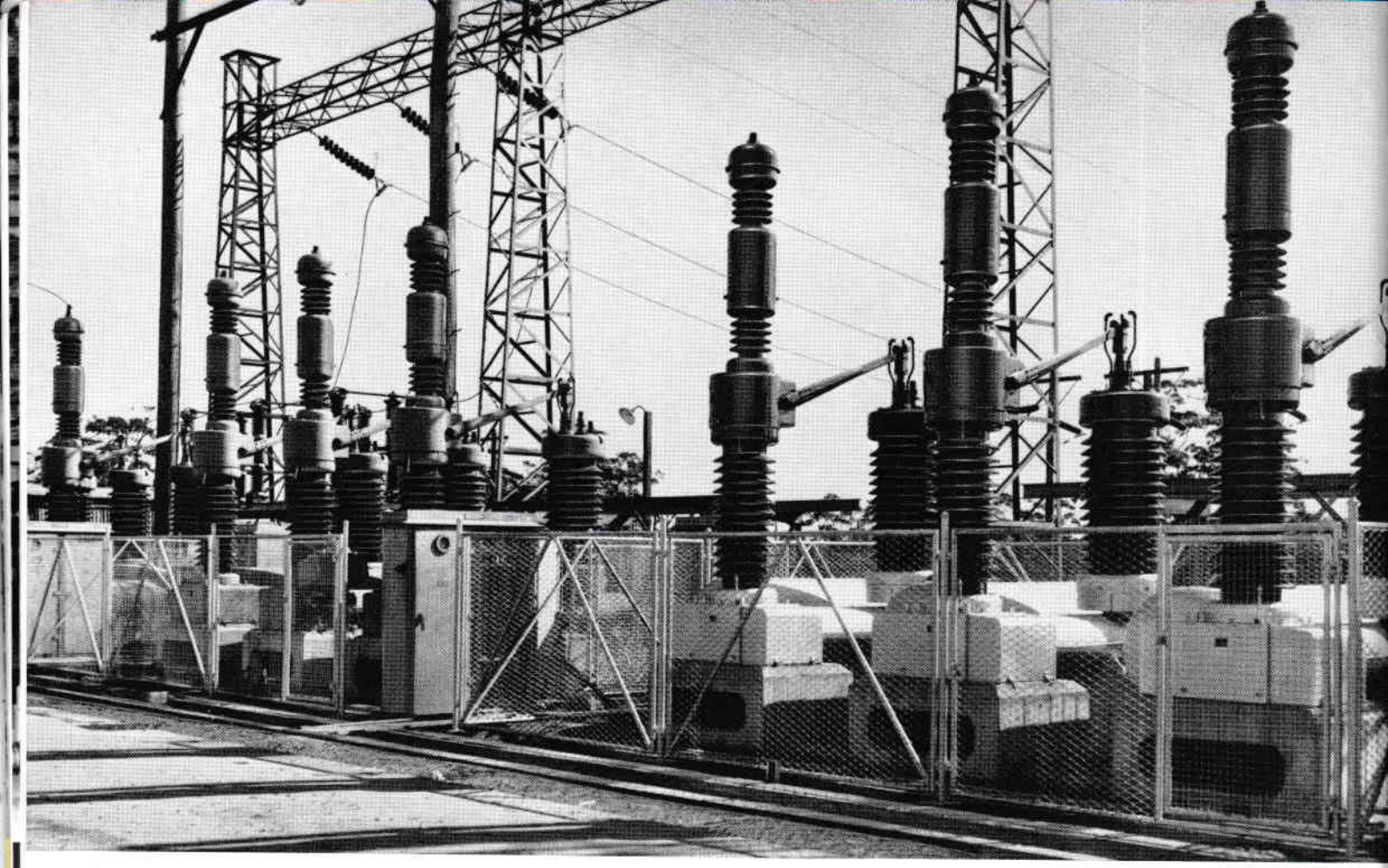
Technical Data

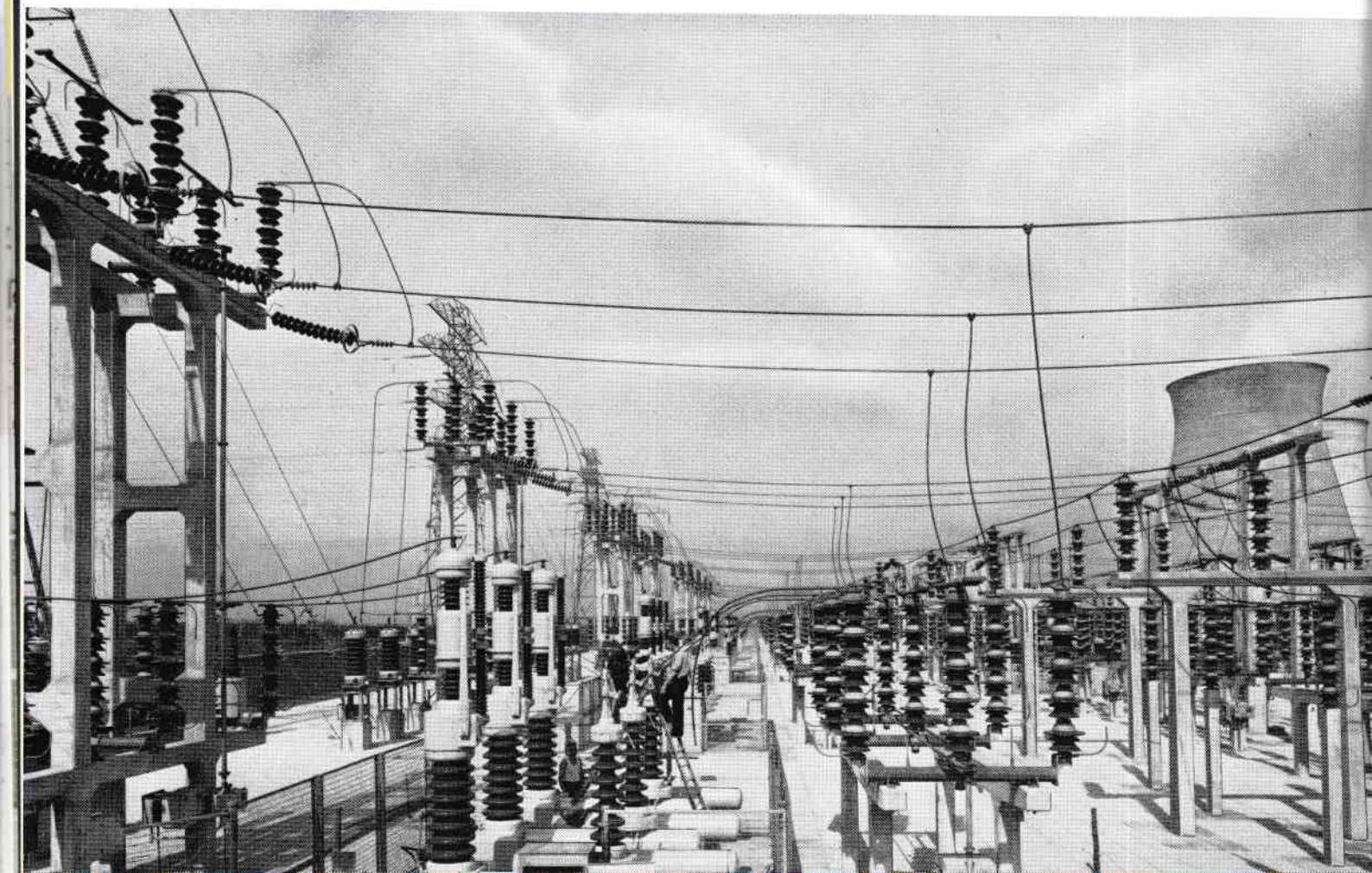
VOLTAGE RATINGS .. .. 110kV, 132kV and 165kV.
CURRENT RATINGS .. .. up to 1,200 amps.
BREAKING-CAPACITIES .. .. up to 5,000 MVA.
IMPULSE LEVEL .. .. 550, 650 and 800 kV WITHSTAND.

Voltage kV	No. of Interrupters per phase	Impulse level kV Withstand 1/50 Wave	Phase Centres		Phase Clearances	
			Inches	Cm.	Inches	Cm.
110	2	550	96	243·84	63	160·02
132	2	650	96	243·84	63	160·02
132	3	650	96	243·84	63	160·02
165	3	800	108	274·32	78	198·12

DIMENSIONS AND WEIGHTS (Approx.)
(See pages 9 and 18)

kV		DIMENSIONS						WEIGHTS			
		Height		Width		Depth		With Integral C.T.		Without Integral C.T.	
		Ins.	Cm.	Ins.	Cm.	Ins.	Cm.	Cwt.	Kg.	Cwt.	Kg.
110	2 Interrupters	176	447·04	241	612·14	128	325·12	165	8382	130	6604
132	2 Interrupters	176	447·04	241	612·14	128	325·12	165	8382	130	6604
132	3 Interrupters	219	556·26	241	612·14	128	325·12	182	9255·6	147	7467·6
165	3 Interrupters	231	586·74	265	673·1	140	355·6	200	10160	160	8128

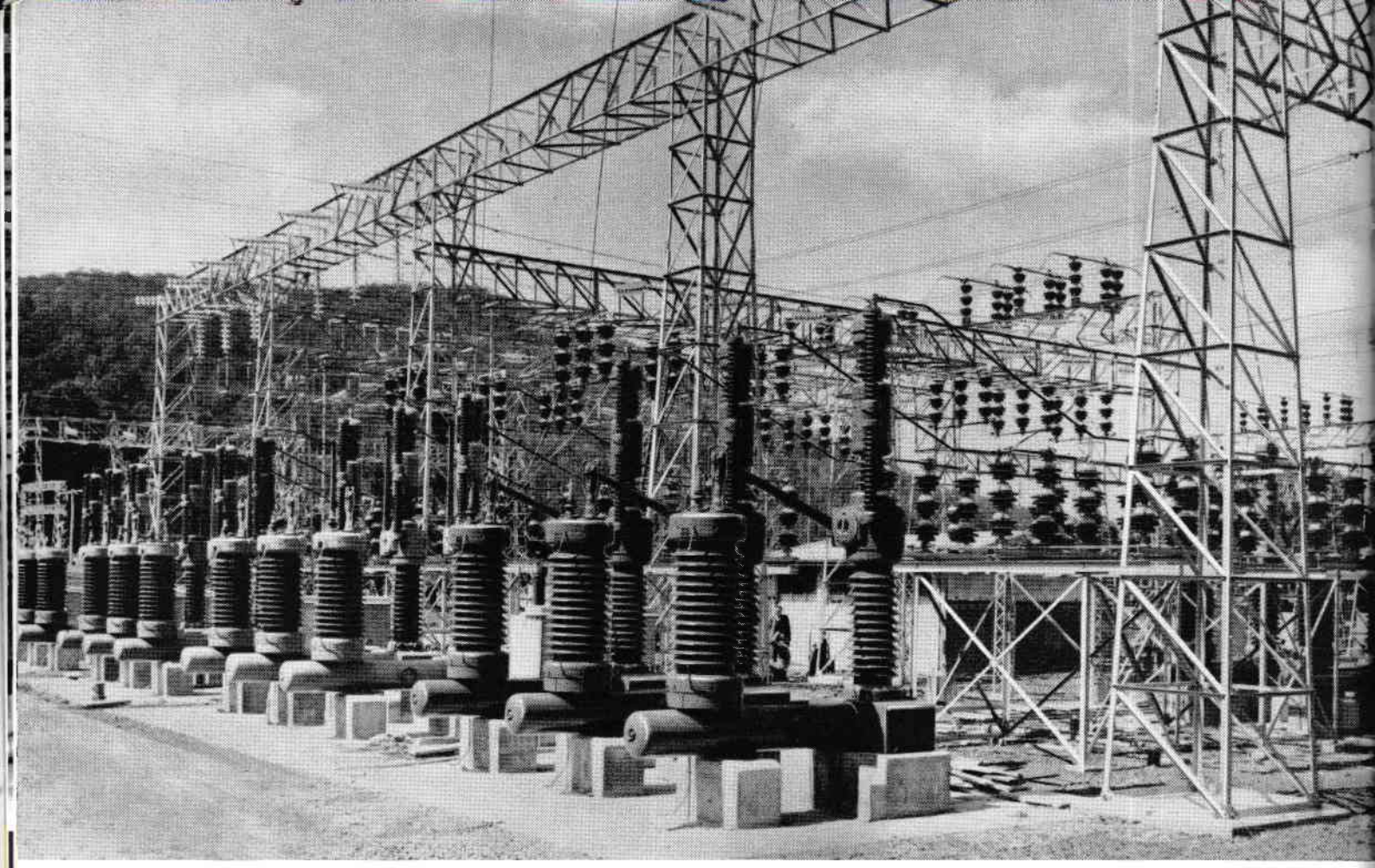


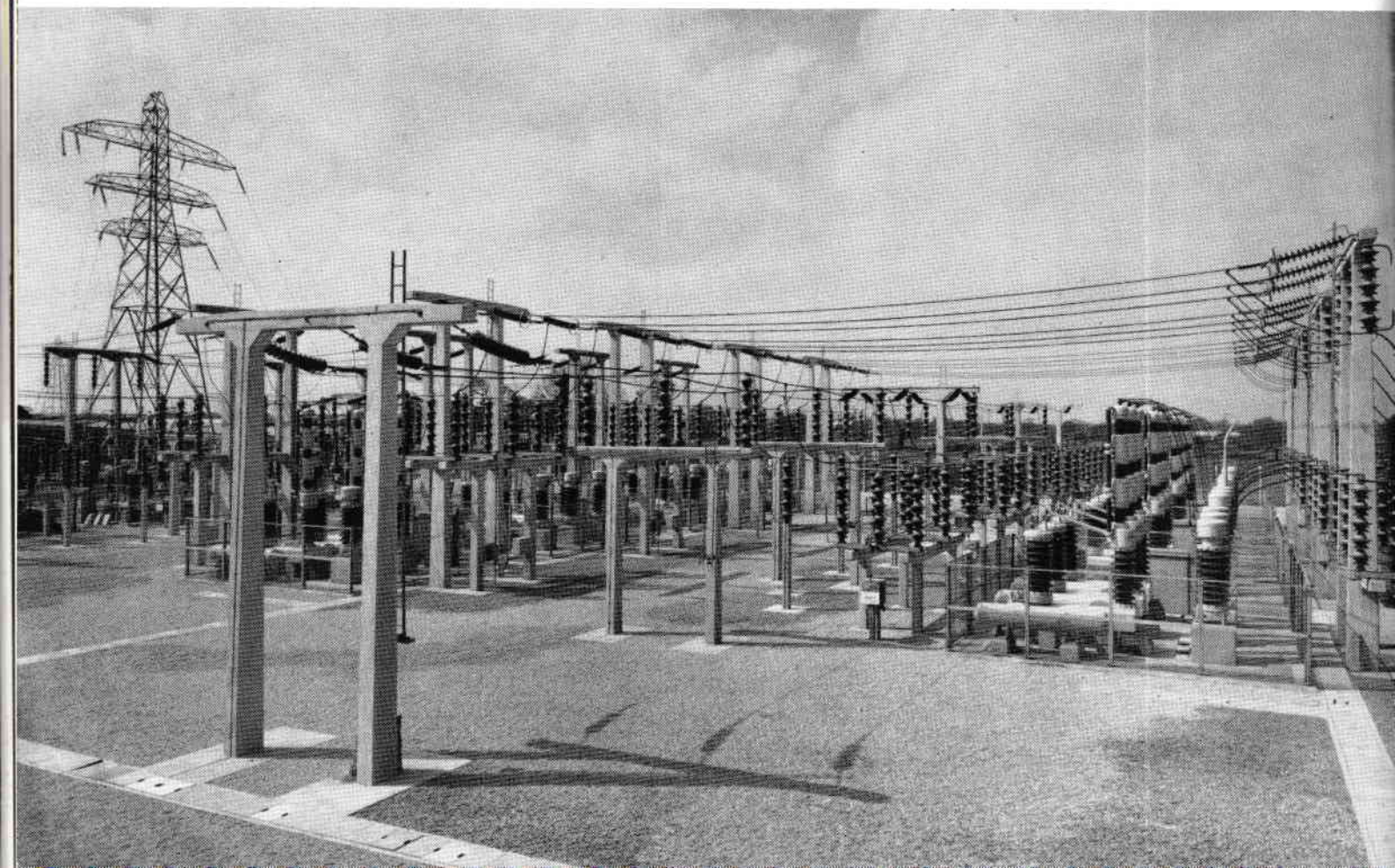


Australia
Carlingford Terminal station of the Electricity Commission of New South Wales equipped with eight 132kV 2500MVA air-blast circuit-breakers.

Canada
115kV 5000MVA air-blast circuit-breakers installed at the Burlington Transformer Station of the Hydro-electric Power Commission of Ontario.

England
Inca Power Station of the C.E.G.B. in the North West, Merseyside and North Wales Region. The 132kV outdoor sub-station equipped with 21 2500MVA air-blast circuit-breakers.

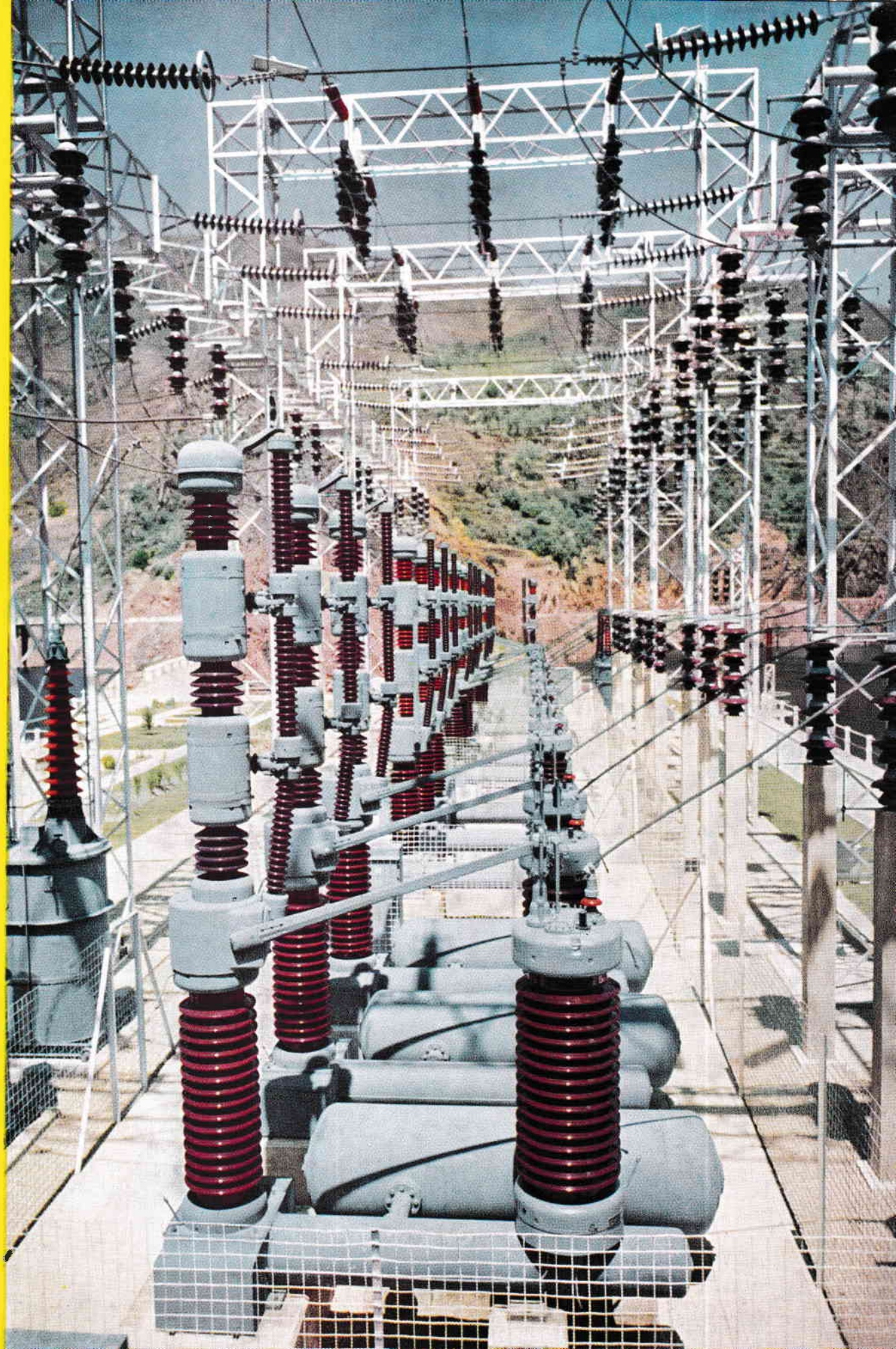




Tasmania
110kV 2500MVA air-blast circuit-breakers at Waddamana Hydro-electric Power Station for the Hydro-electric Commission, Tasmania.

Spain
Switching station for the Ponte Novo H.E. Power Station of Saltos del Sil S.A. containing 165kV 3500MVA air-blast circuit-breakers.

England
Intermediate double-busbar sub-station in the North West, Merseyside and North Wales Region of the C.E.G.B. equipped with 132kV 3500MVA air-blast circuit-breakers.



FRAME...

Air-Blast Circuit-Breakers

The ENGLISH ELECTRIC Company Limited

SWITCHGEAR DEPARTMENT · STAFFORD

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